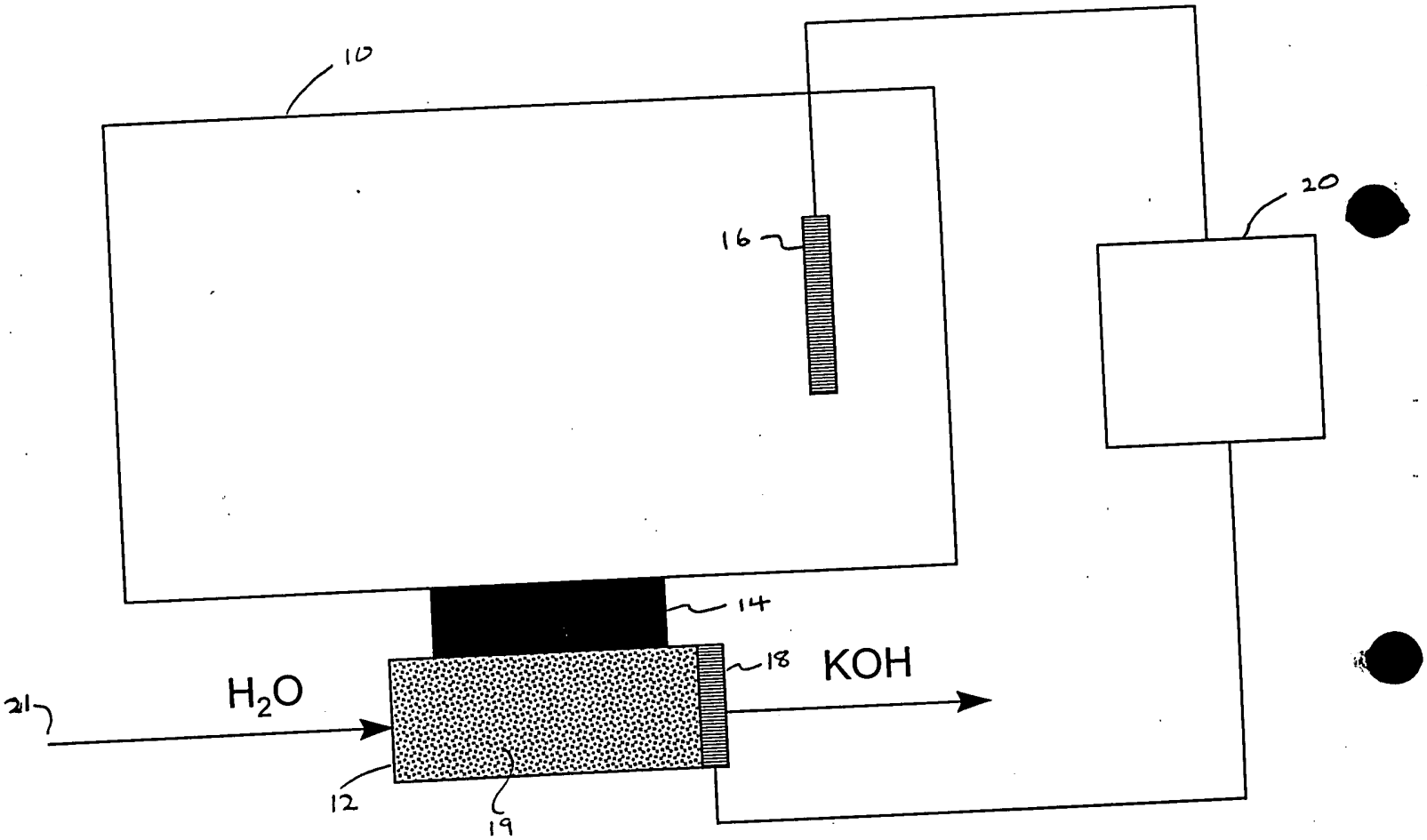



Figure 1.

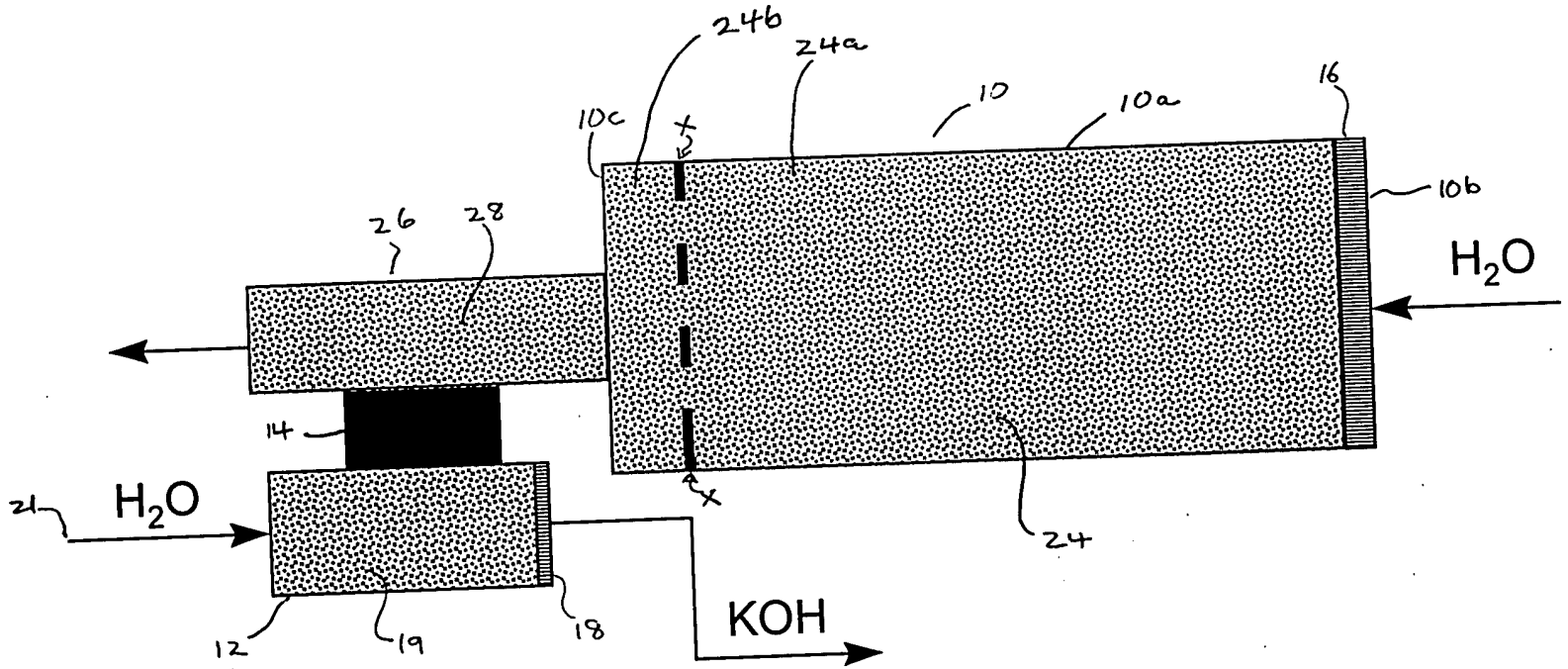



Figure 2.

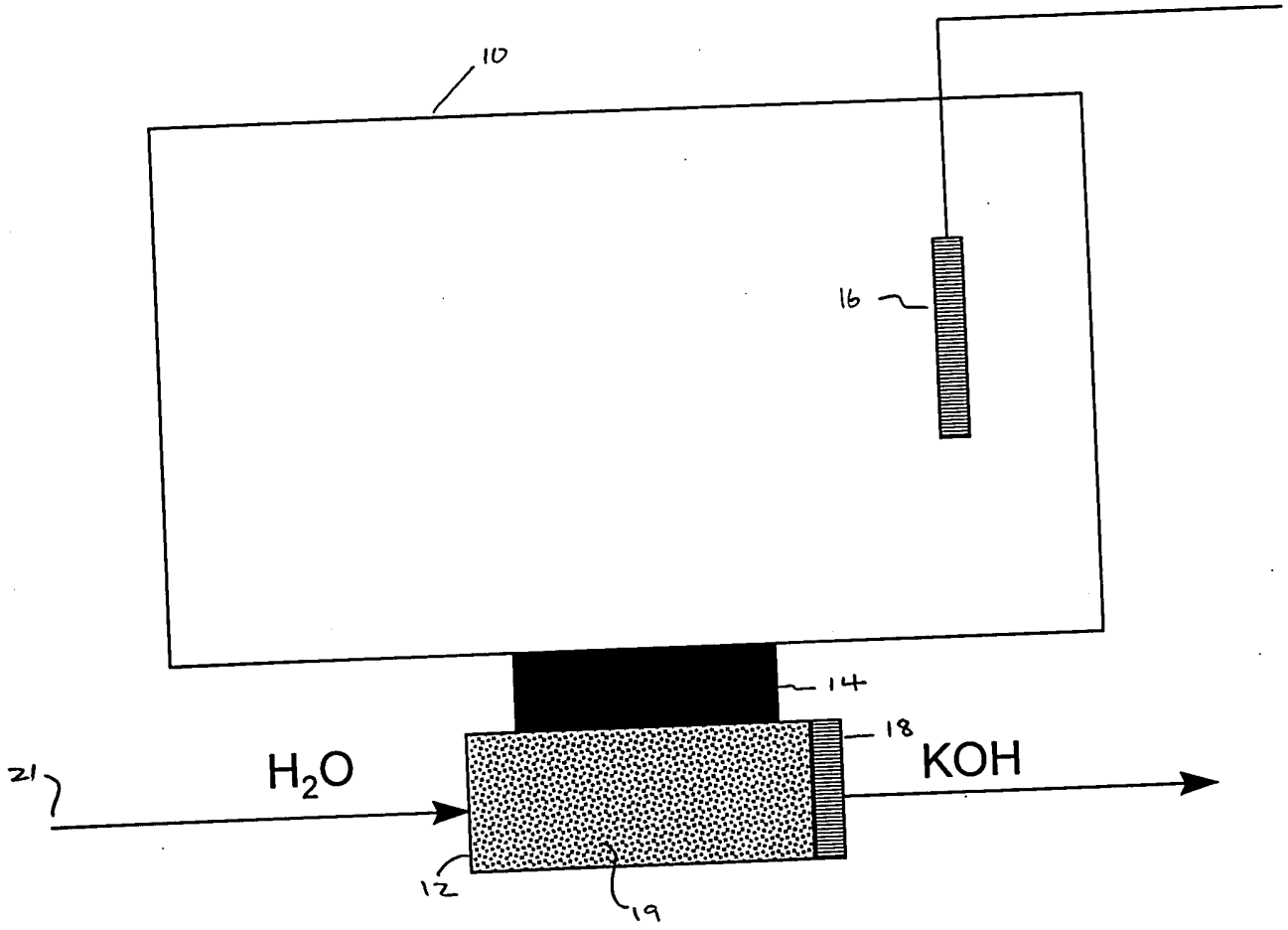



Figure 3.

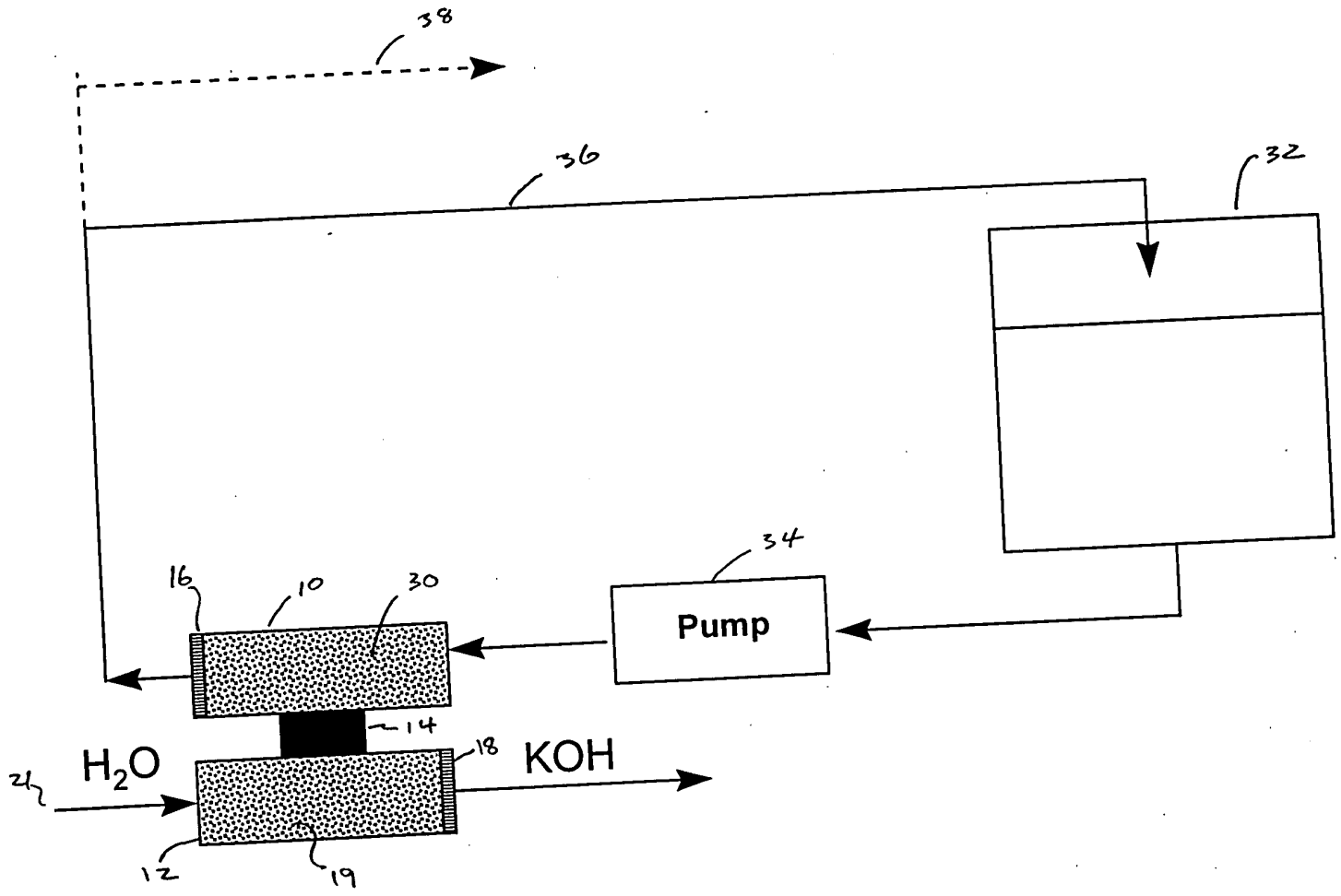



Figure 4.

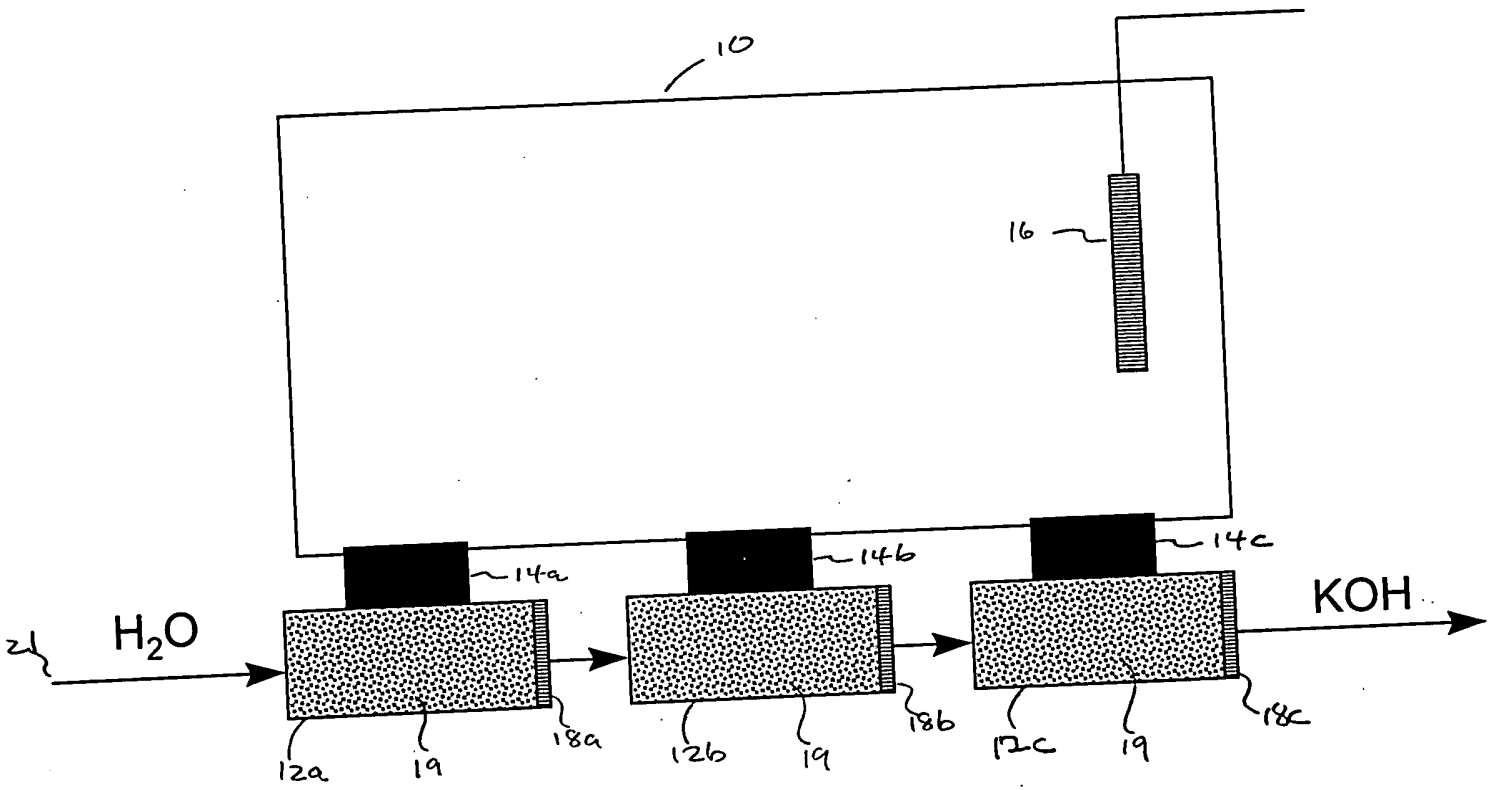



Figure 5.

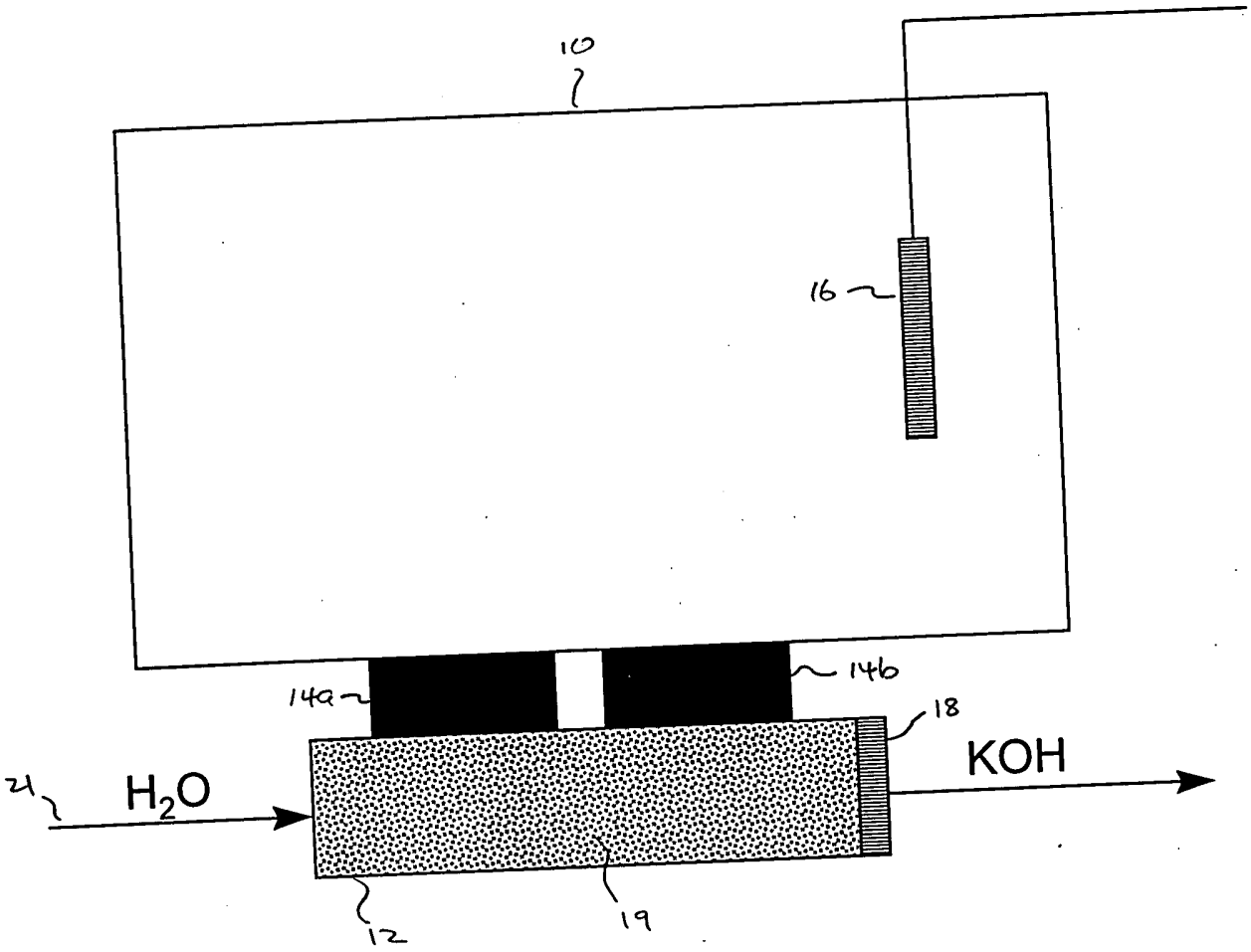



Figure 6.

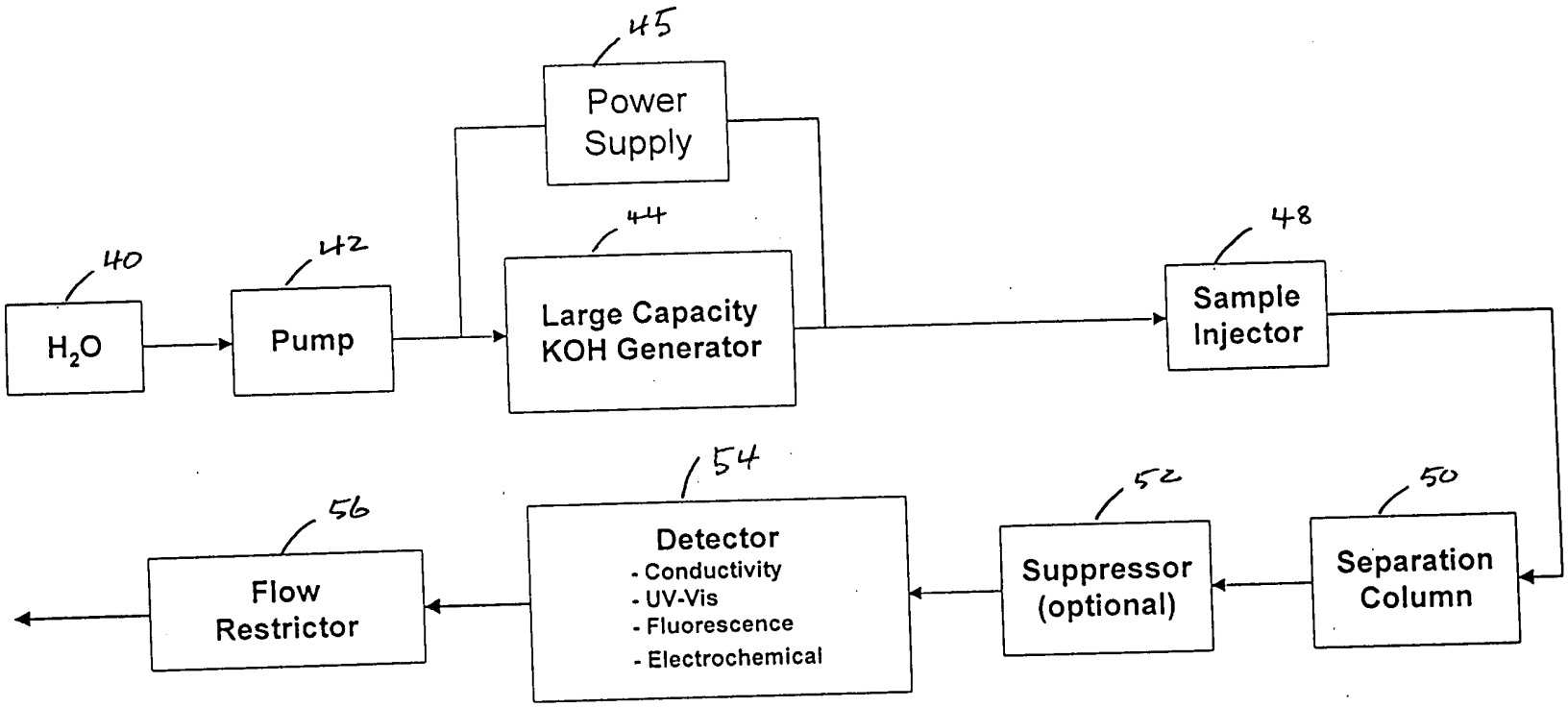

45
Power Supply
44
48
40
42
$H_2O$
Pump
Large Capacity KOH Generator
Sample Injector
54
52
50
56
Detector
- Conductivity
- UV-Vis
- Fluorescence
- Electrochemical
Suppressor (optional)
Separation Column
Flow Restrictor

Figure 7.

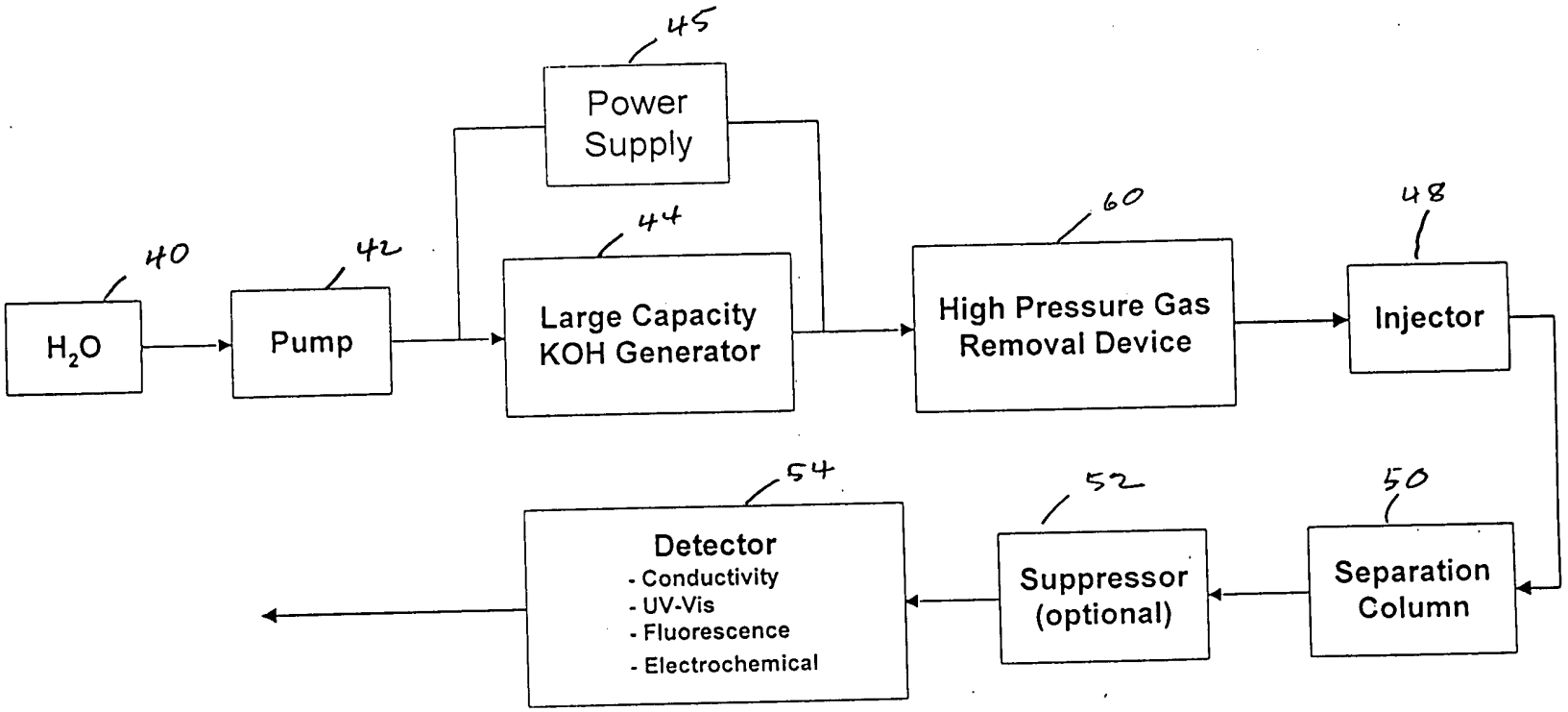

45
Power Supply
40
42
44
60
48
$H_2O$
Pump
Large Capacity KOH Generator
High Pressure Gas Removal Device
Injector
54
52
50
Detector
- Conductivity
- UV-Vis
- Fluorescence
- Electrochemical
Suppressor (optional)
Separation Column

Figure 8.

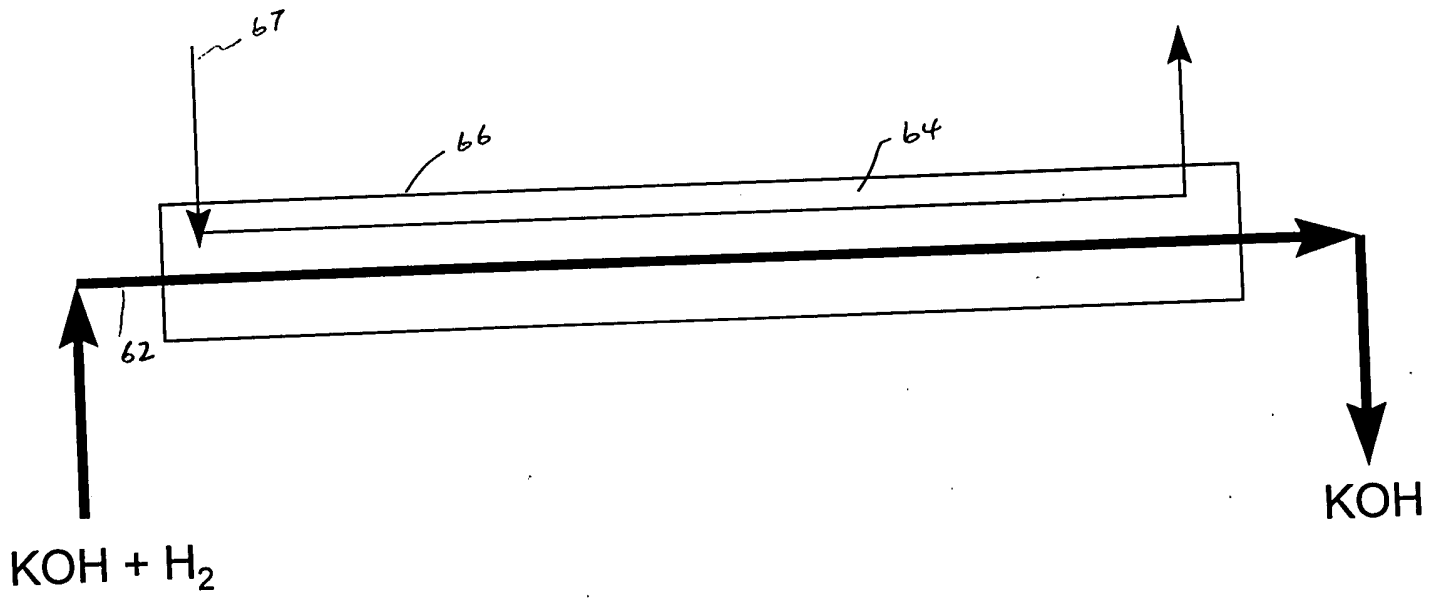



Figure 9.

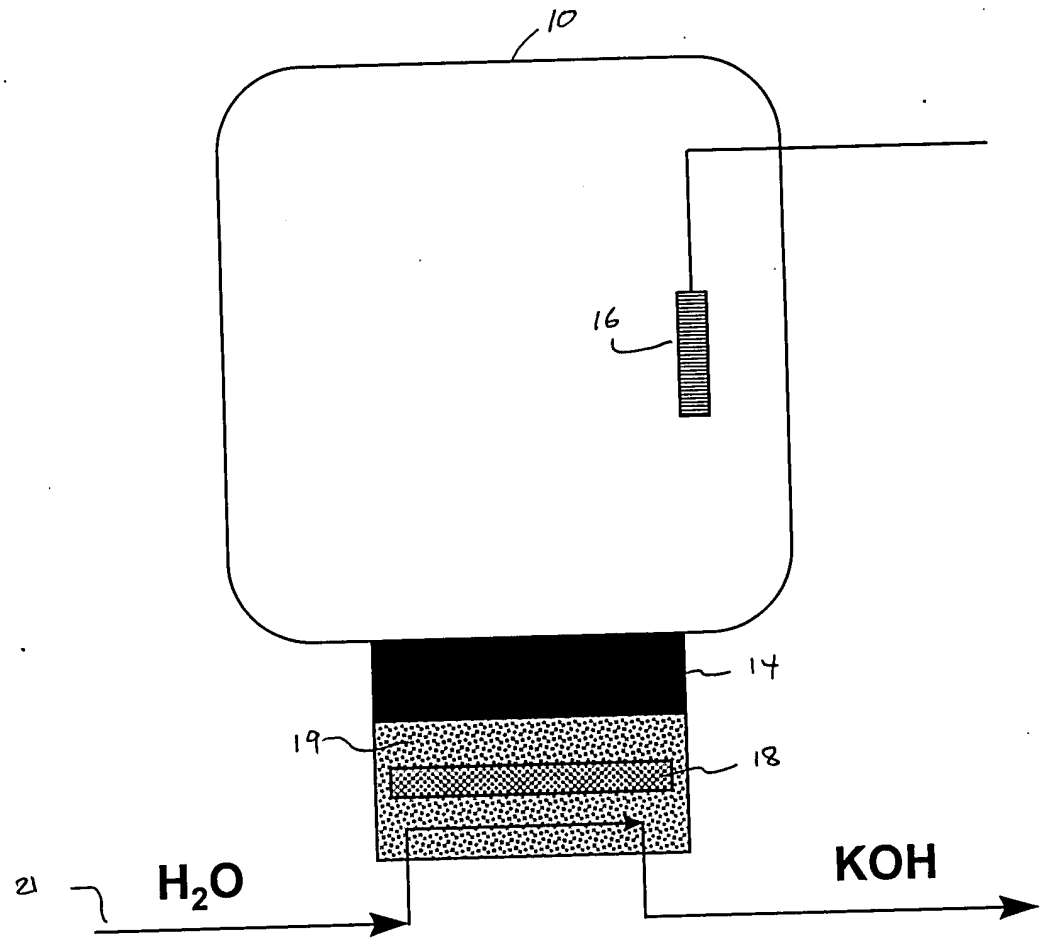



Figure 10.

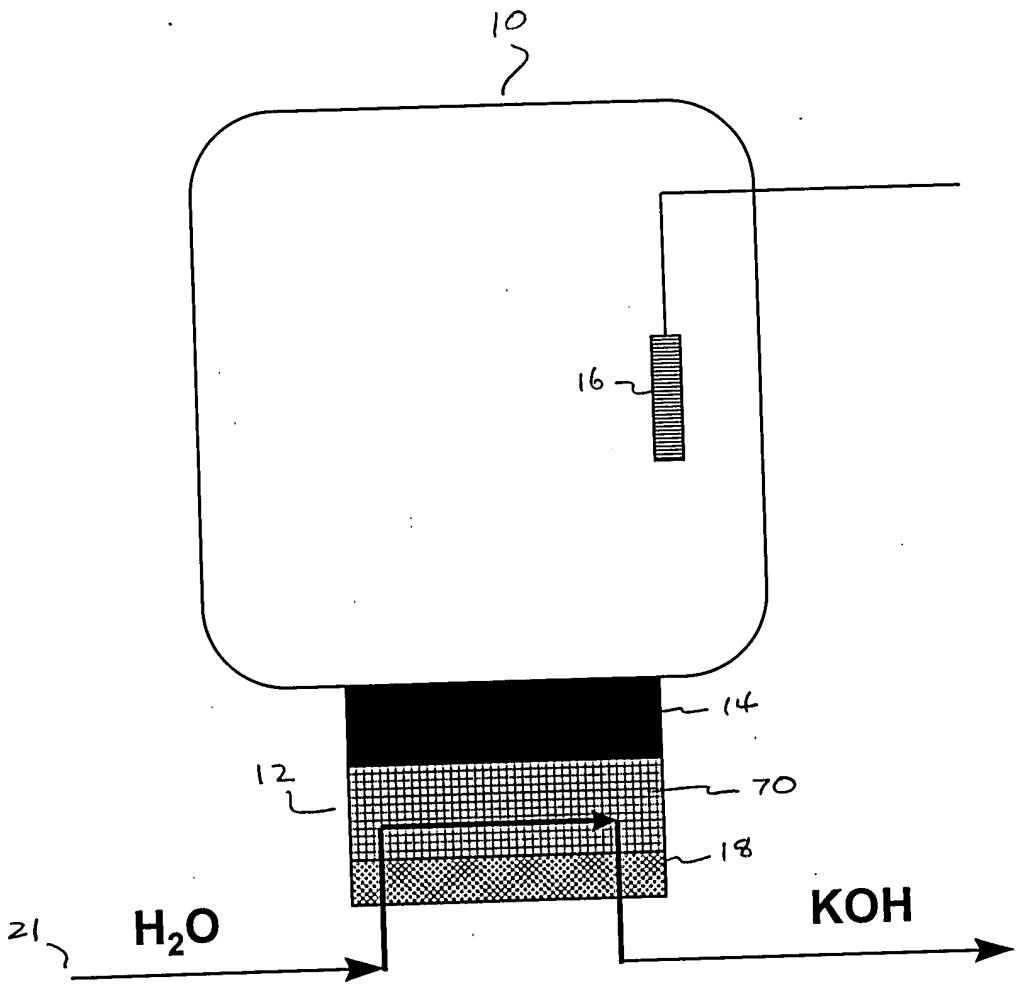



Figure 11.

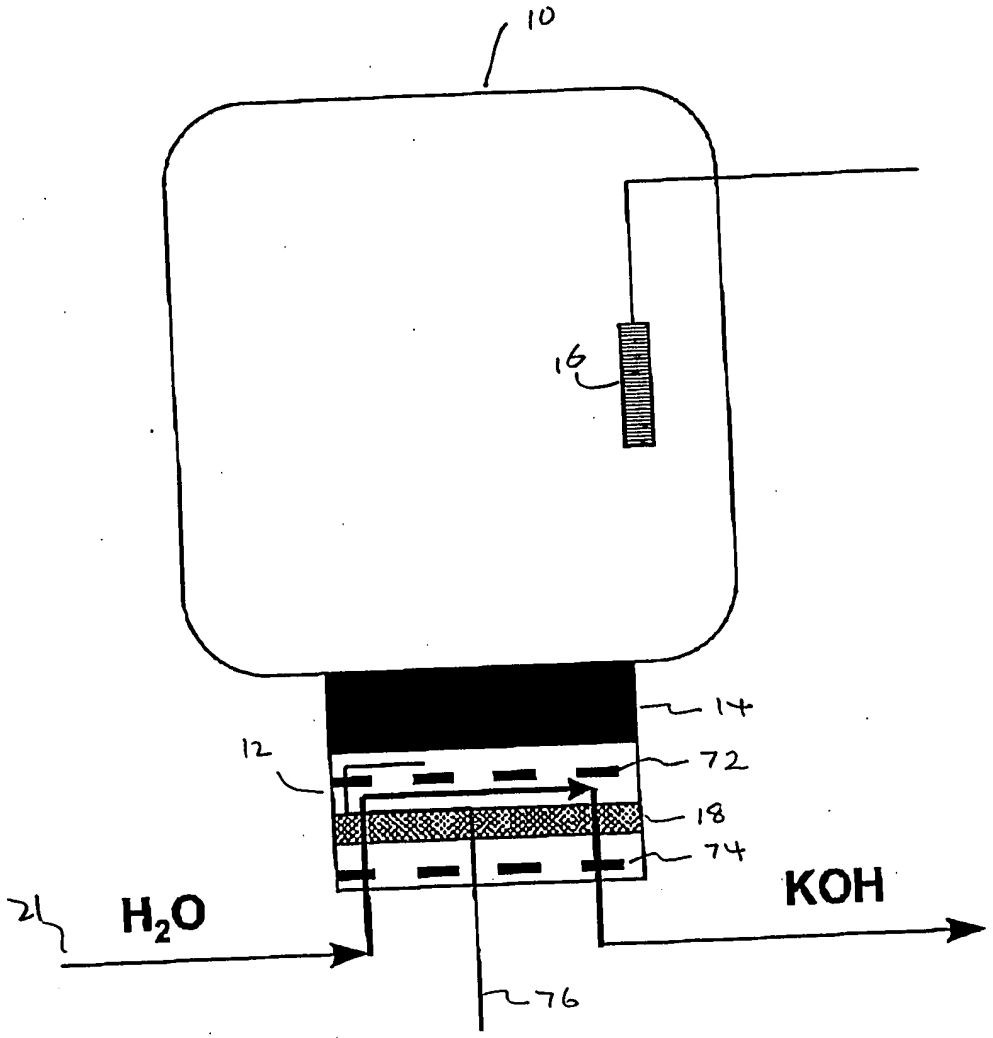
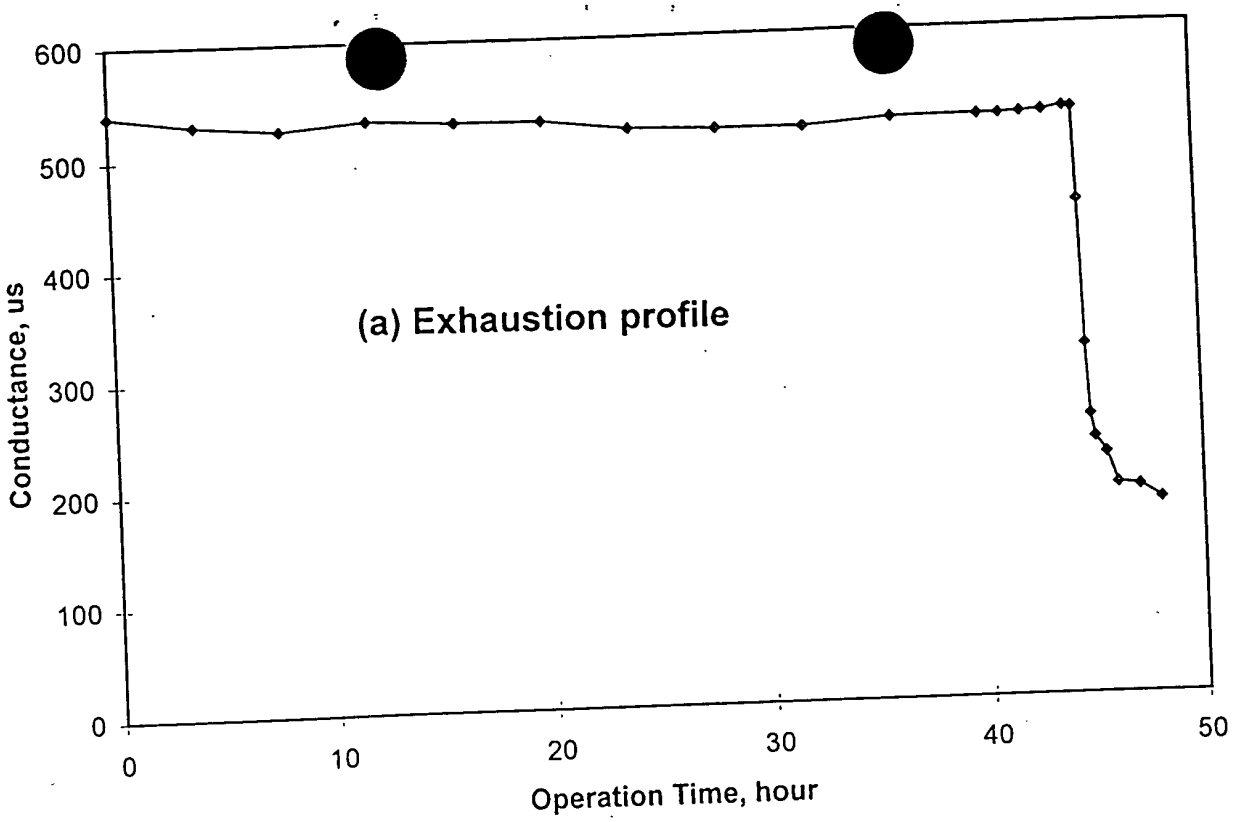



Figure 12.


(a) Exhaustion profile
Conductance, us
600
500
400
300
200
100
0
0
10
20
30
40
50
Operation Time, hour

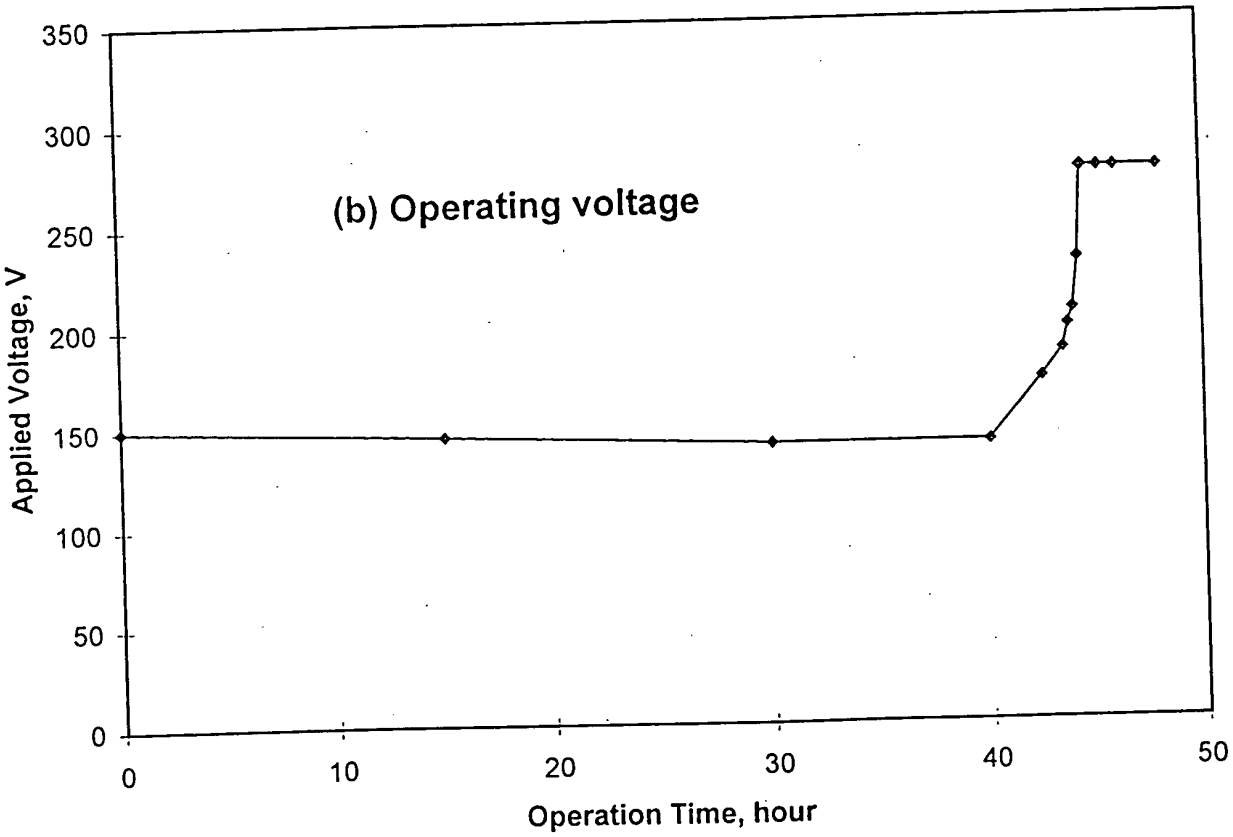

(b) Operating voltage
Applied Voltage, V
350
300
250
200
150
100
50
0
0
10
20
30
40
50
Operation Time, hour

Figure 13.

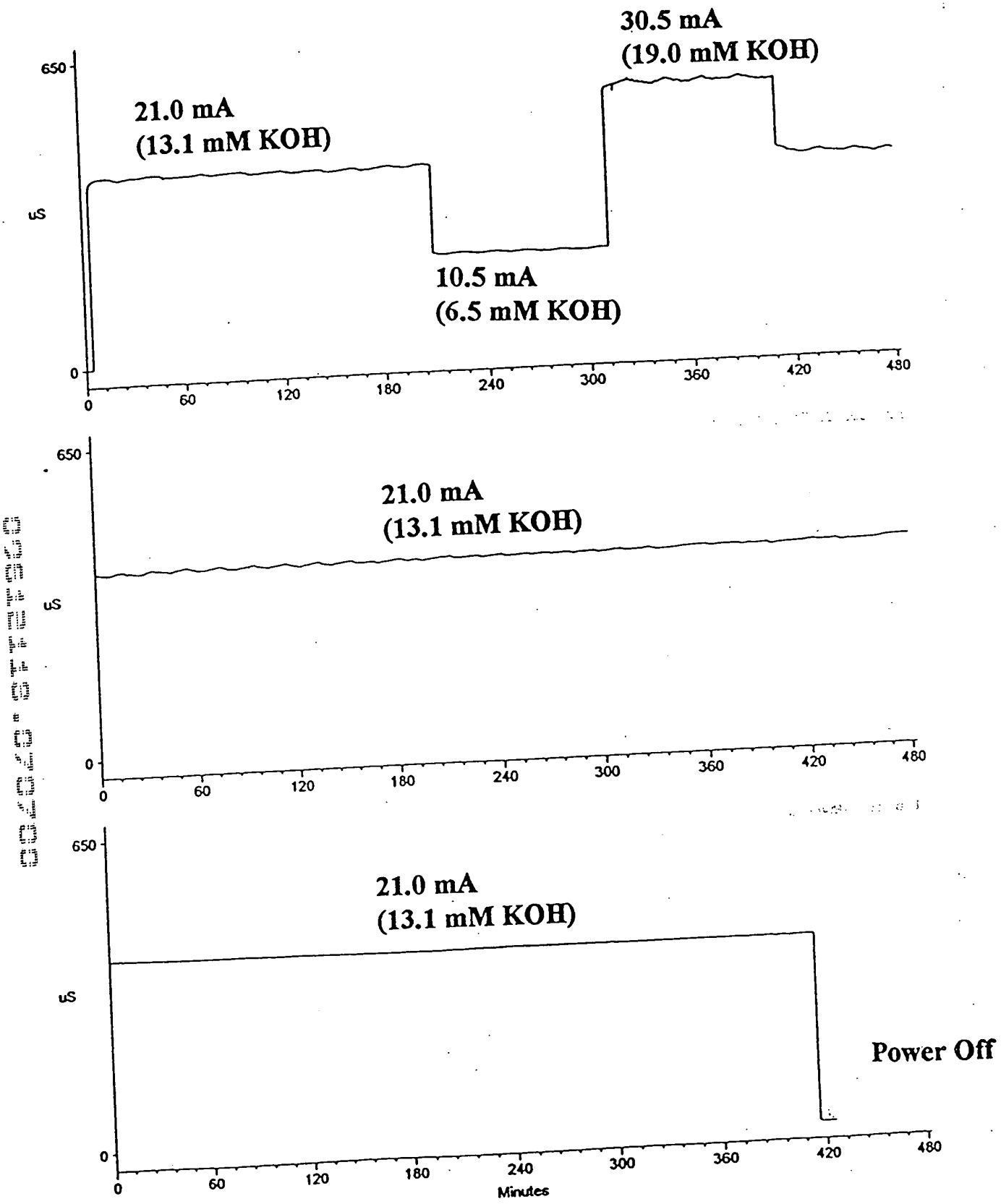

30.5 mA
(19.0 mM KOH)
21.0 mA
(13.1 mM KOH)
10.5 mA
(6.5 mM KOH)
650
0
uS
0
60
120
180
240
300
360
420
480
21.0 mA
(13.1 mM KOH)
650
0
uS
0
60
120
180
240
300
360
420
480
21.0 mA
(13.1 mM KOH)
650
0
uS
Power Off
0
60
120
180
240
300
360
420
480
Minutes

Figure 14.

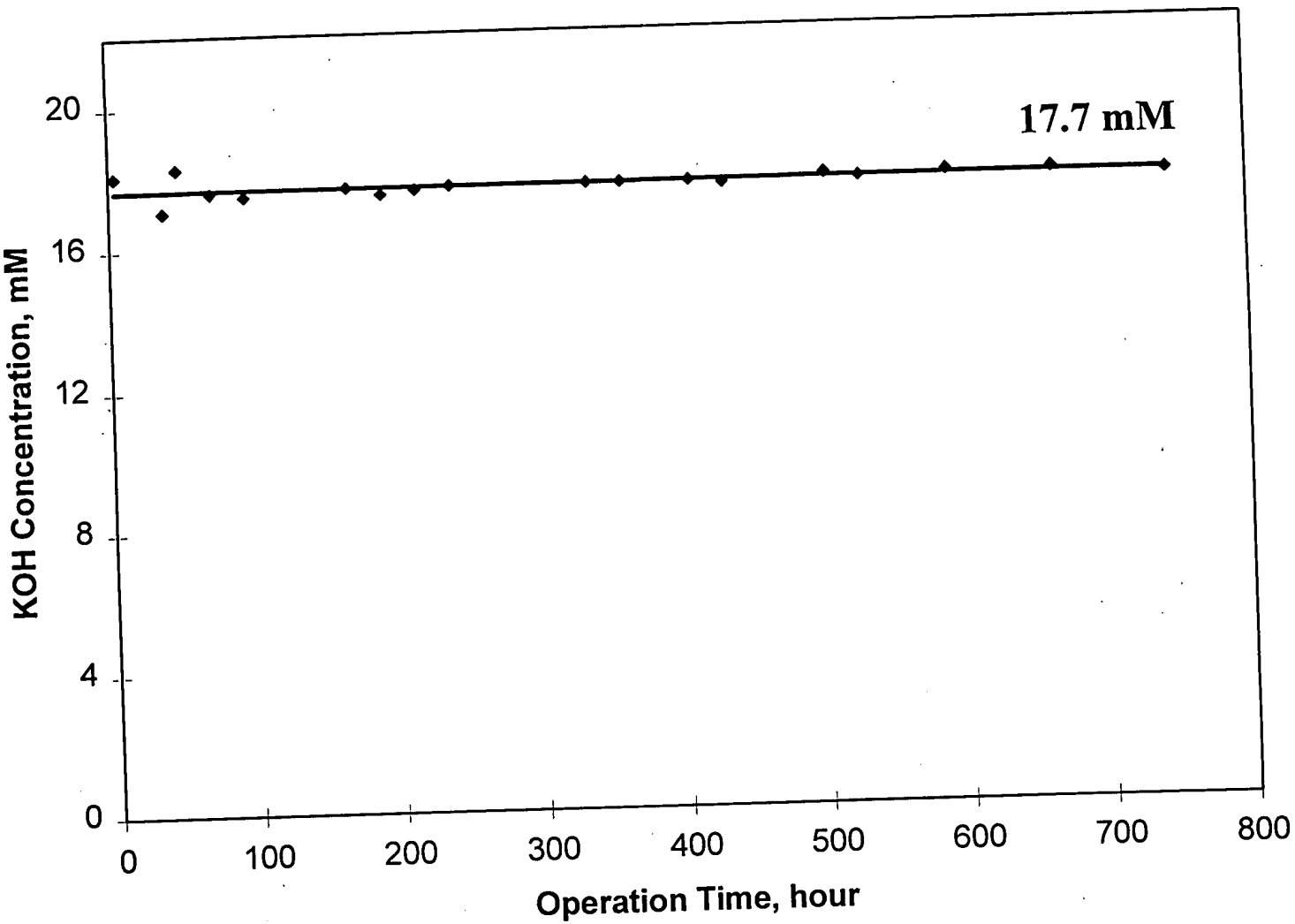

17.7 mM
KOH Concentration, mM
20
16
12
8
4
0
0
100
200
300
400
500
600
700
800
Operation Time, hour

Figure 15.

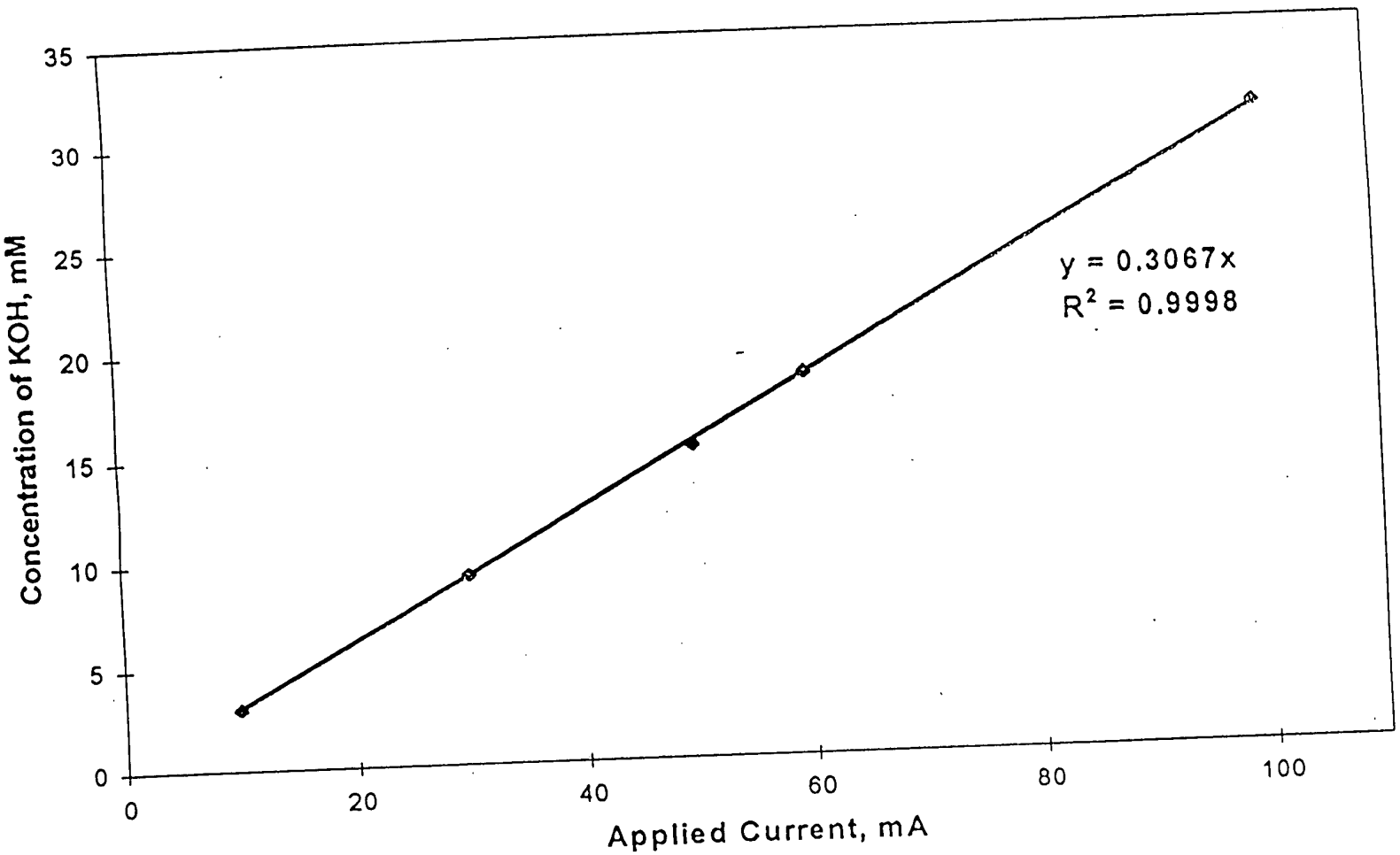



Figure 16

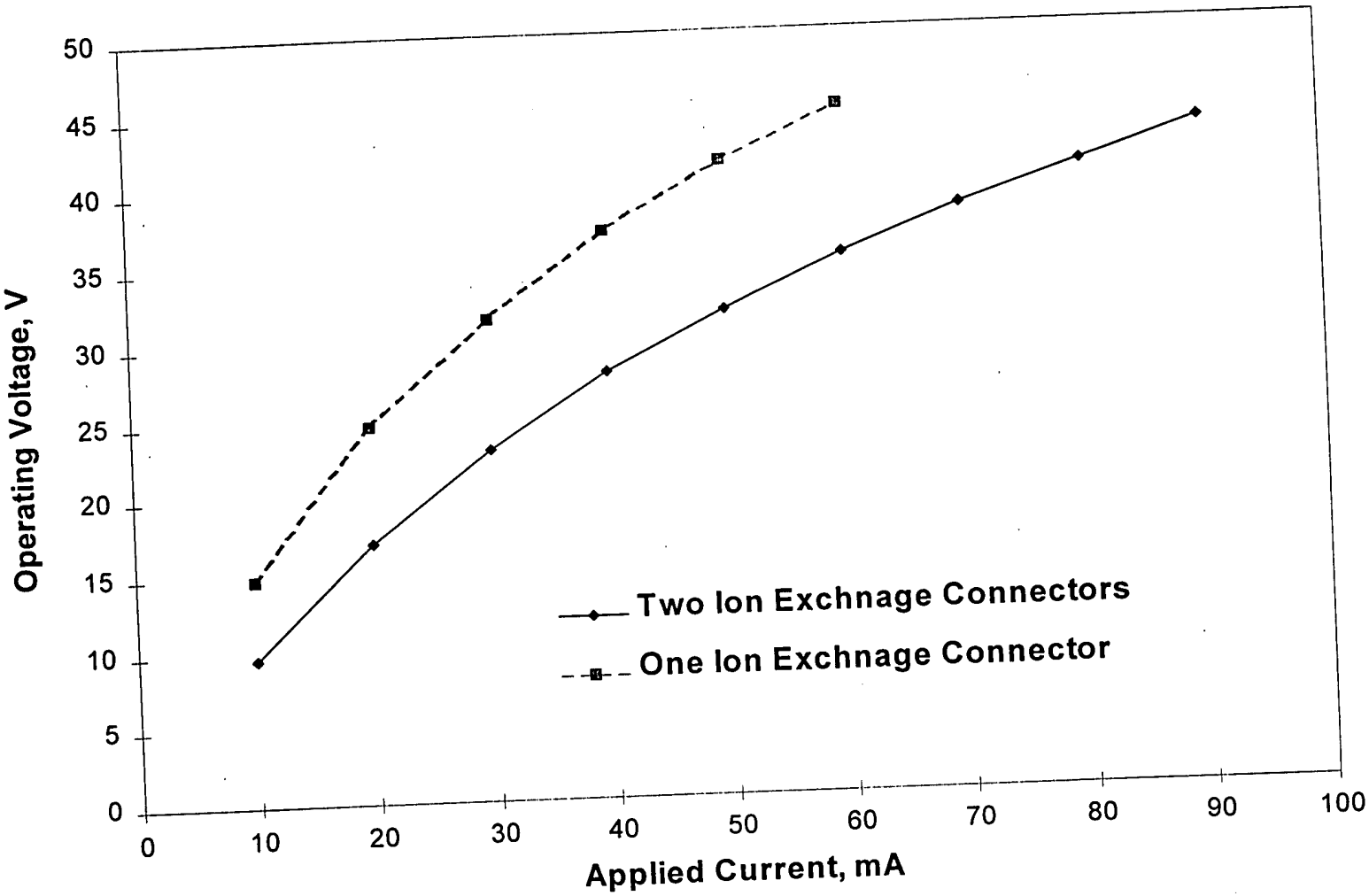

Operating Voltage, V
50
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
Applied Current, mA
Two Ion Exchnage Connectors
One Ion Exchnage Connector

Figure 17

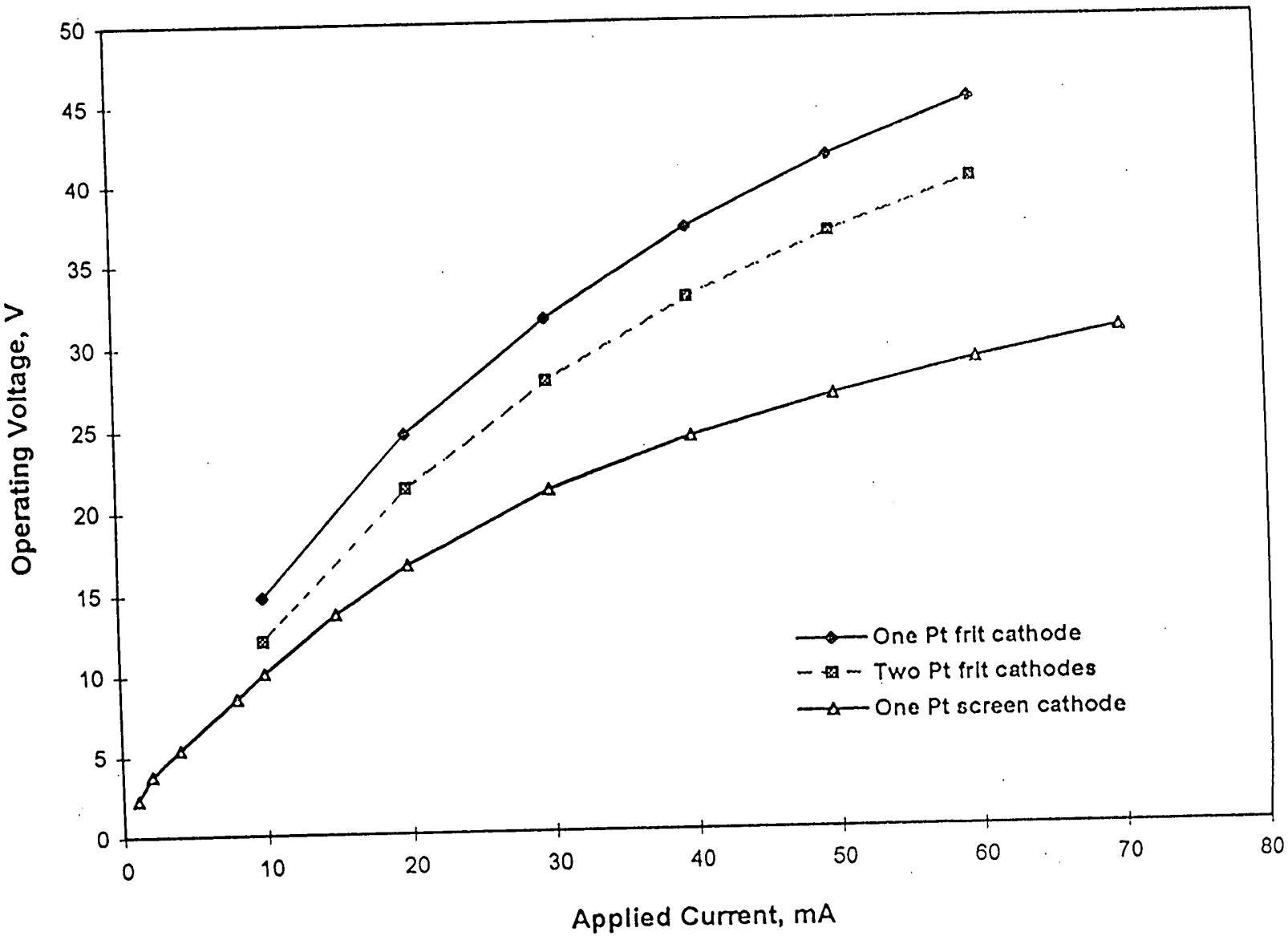

Operating Voltage, V
Applied Current, mA
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
One Pt frit cathode
Two Pt frit cathodes
One Pt screen cathode

Figure 18

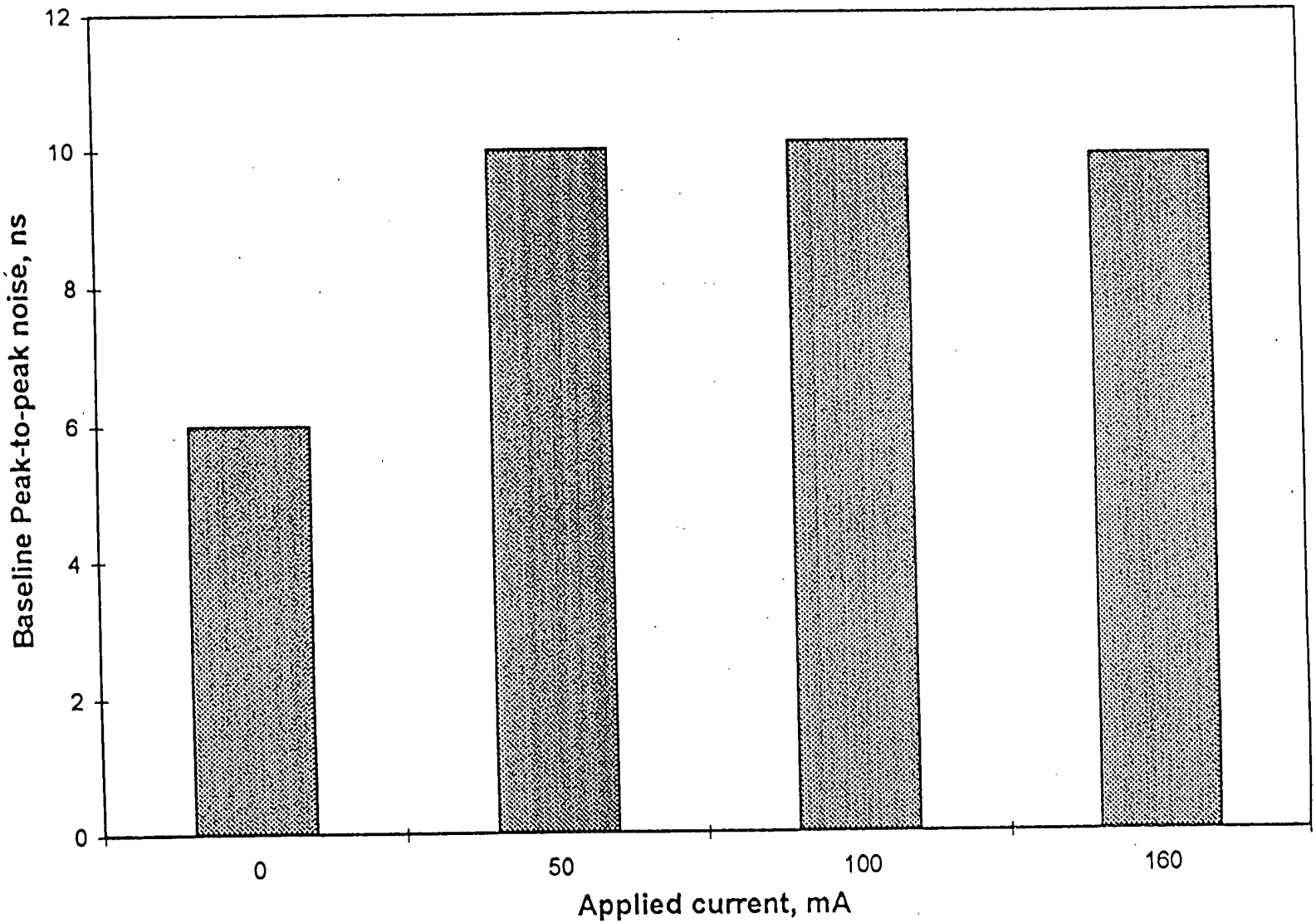

12
10
8
6
4
2
0
Baseline Peak-to-peak noise, ns
0
50
100
160
Applied current, mA

Figure 19

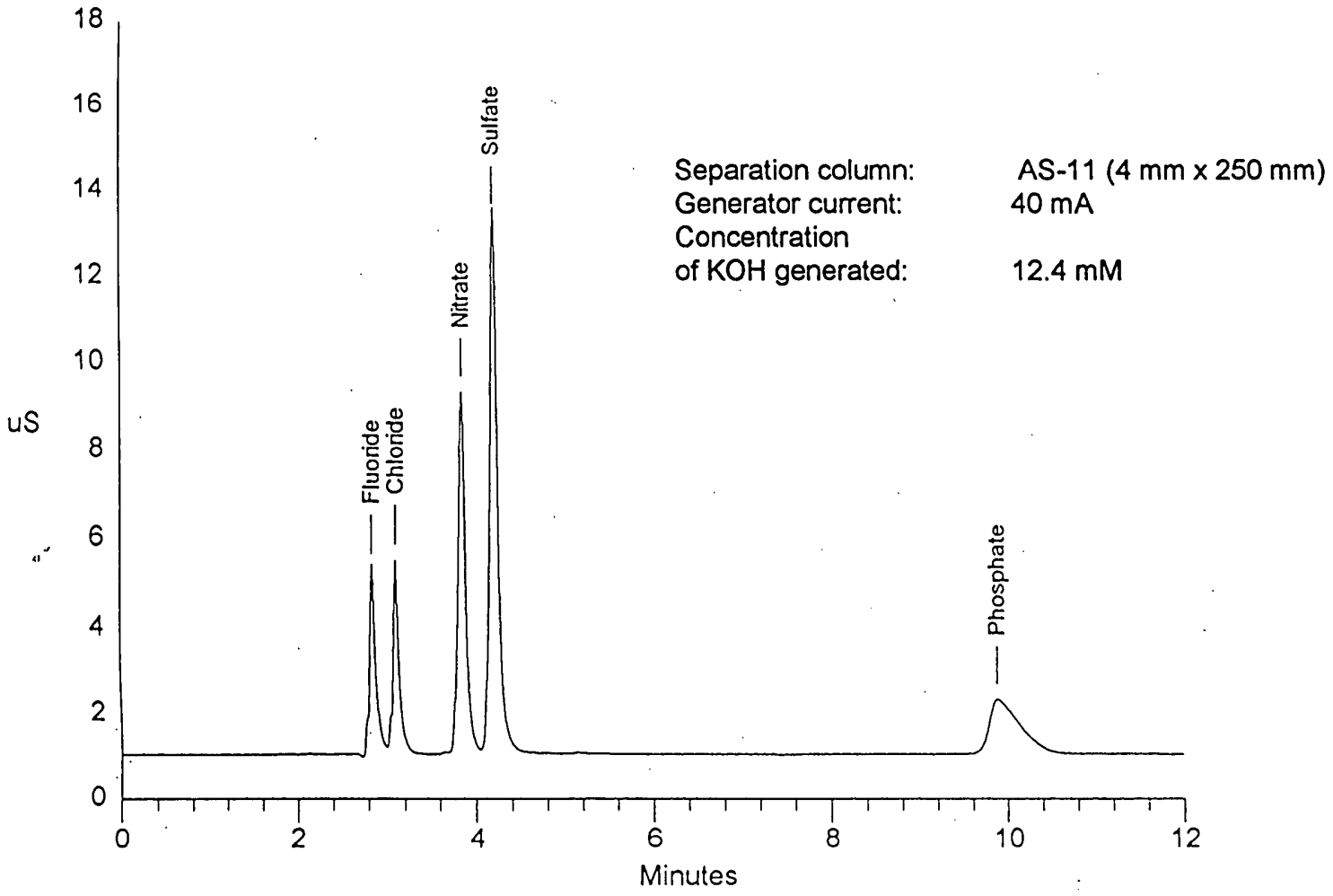

Separation column: AS-11 (4 mm x 250 mm)
Generator current: 40 mA
Concentration
of KOH generated: 12.4 mM
uS
Minutes
Fluoride
Chloride
Nitrate
Sulfate
Phosphate
0
2
4
6
8
10
12
14
16
18

Figure 20.

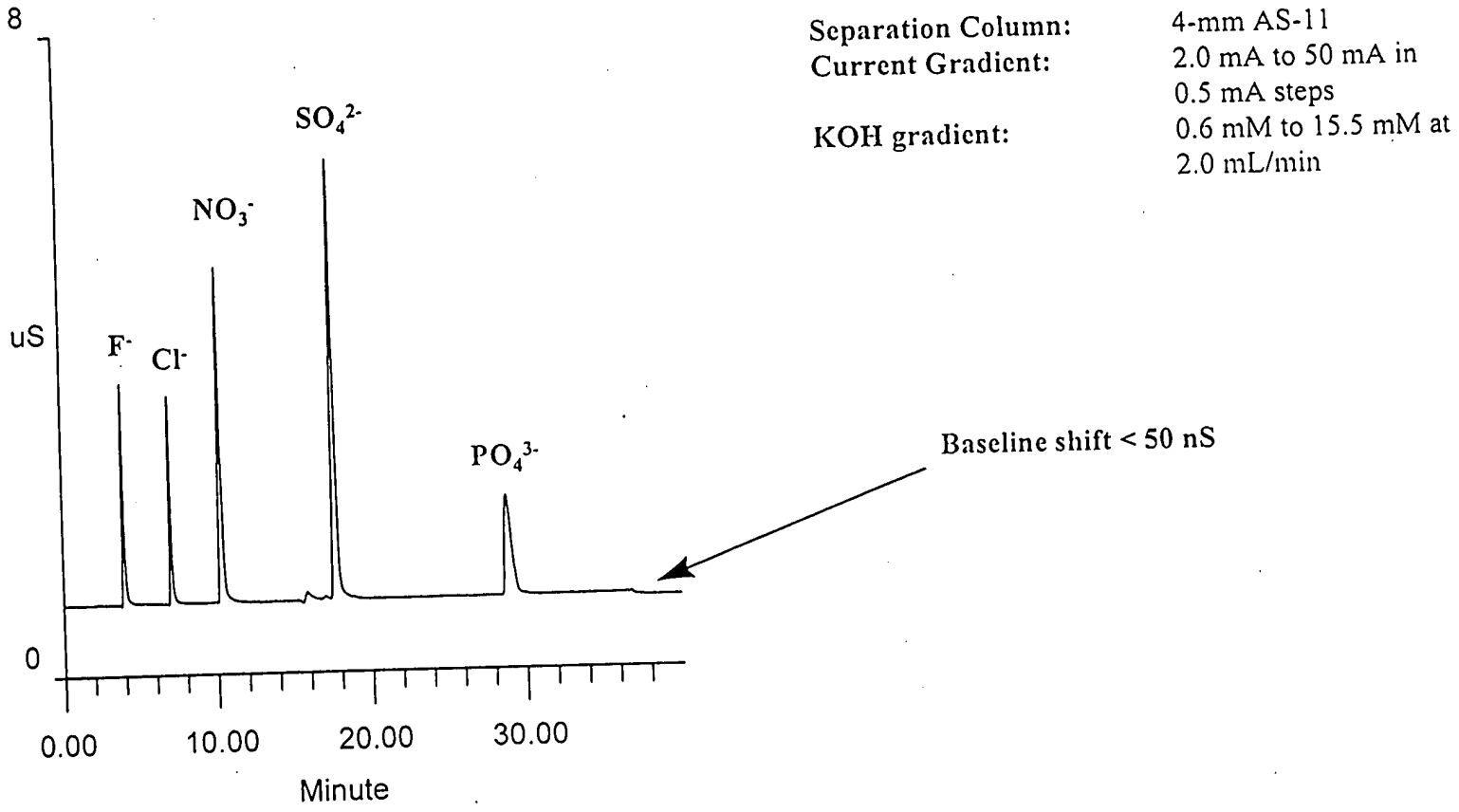

8
uS
0
$F^-$
$Cl^-$
$NO_3^-$
$SO_4^{2-}$
$PO_4^{3-}$
0.00
10.00
20.00
30.00
Minute
Separation Column: 4-mm AS-11
Current Gradient: 2.0 mA to 50 mA in 0.5 mA steps
KOH gradient: 0.6 mM to 15.5 mM at 2.0 mL/min
Baseline shift < 50 nS

Figure 21.

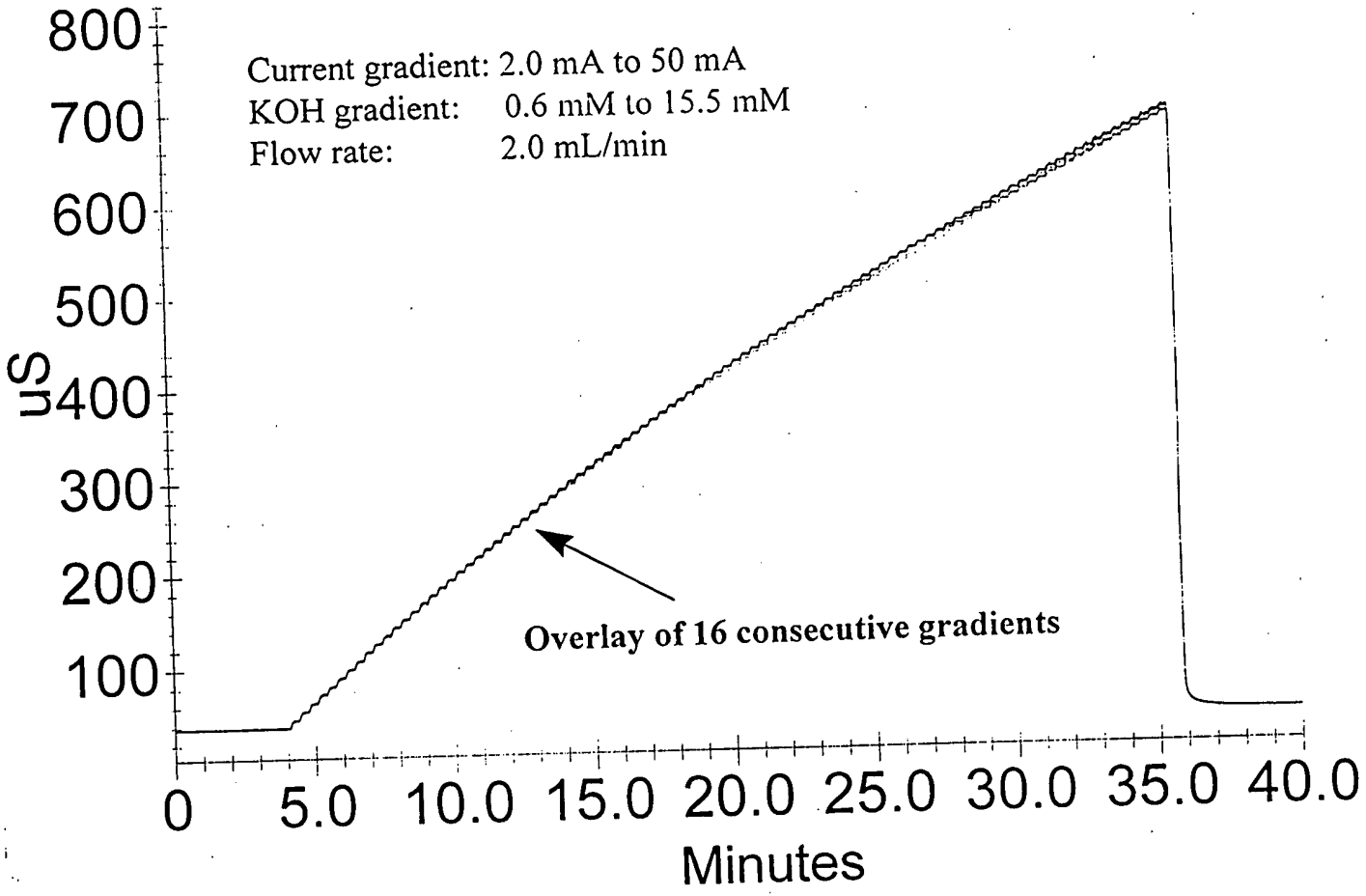
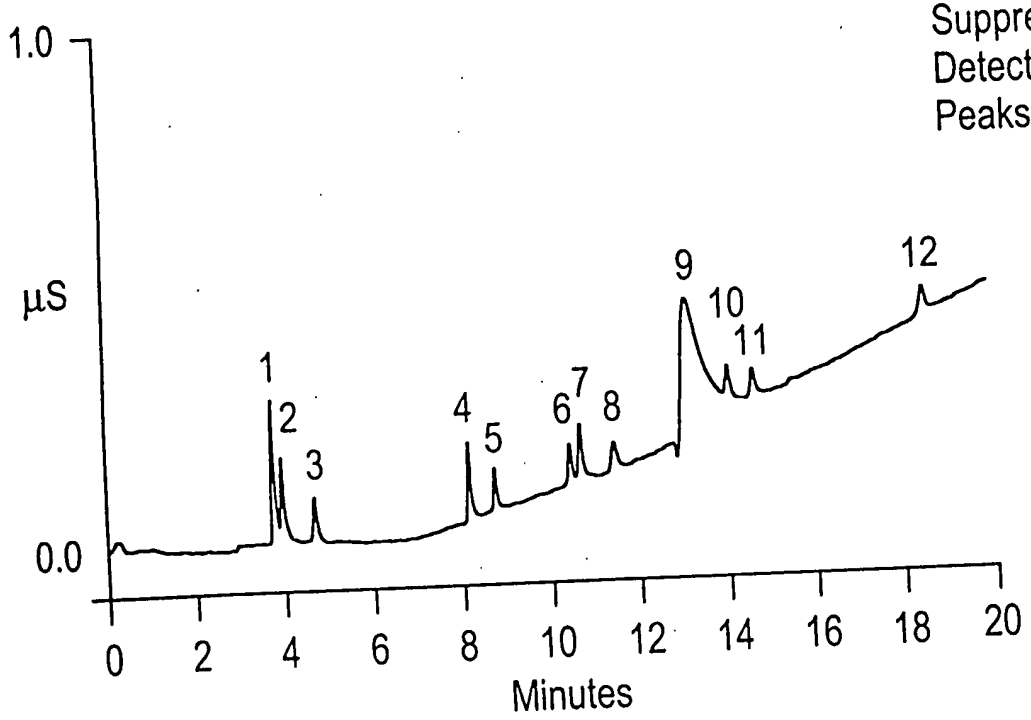

Current gradient: 2.0 mA to 50 mA
KOH gradient: 0.6 mM to 15.5 mM
Flow rate: 2.0 mL/min
Overlay of 16 consecutive gradients
uS
800
700
600
500
400
300
200
100
0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Minutes

Figure 22.




Column: IonPac® AG11, AS11, 2 mm
Eluent: Sodium hydroxide
0.5 mM to 2.5 min to 5.0 mM at 6 min,
to 26 mM at 20 min
Flow Rate: 0.5 mL/min
Inj. Volume: 750 µL
Suppressor: ASRS, external water mode
Detection: Conductivity

Peaks:

| | | |
|---|---|---|
| 1. | Fluoride | 1.4 µg/L (ppb) |
| 2. | Acetate | 3.0 |
| 3. | Formate | 0.88 |
| 4. | Chloride | 1.2 |
| 5. | Nitrite | 0.71 |
| 6. | Bromide | 1.6 |
| 7. | Nitrate | 1.8 |
| 8. | Unidentified | – |
| 9. | Carbonate | – |
| 10. | Sulfate | 0.81 |
| 11. | Oxalate | 1.3 |
| 12. | Phosphate | 3.2 |

11515-01

Figure 23.

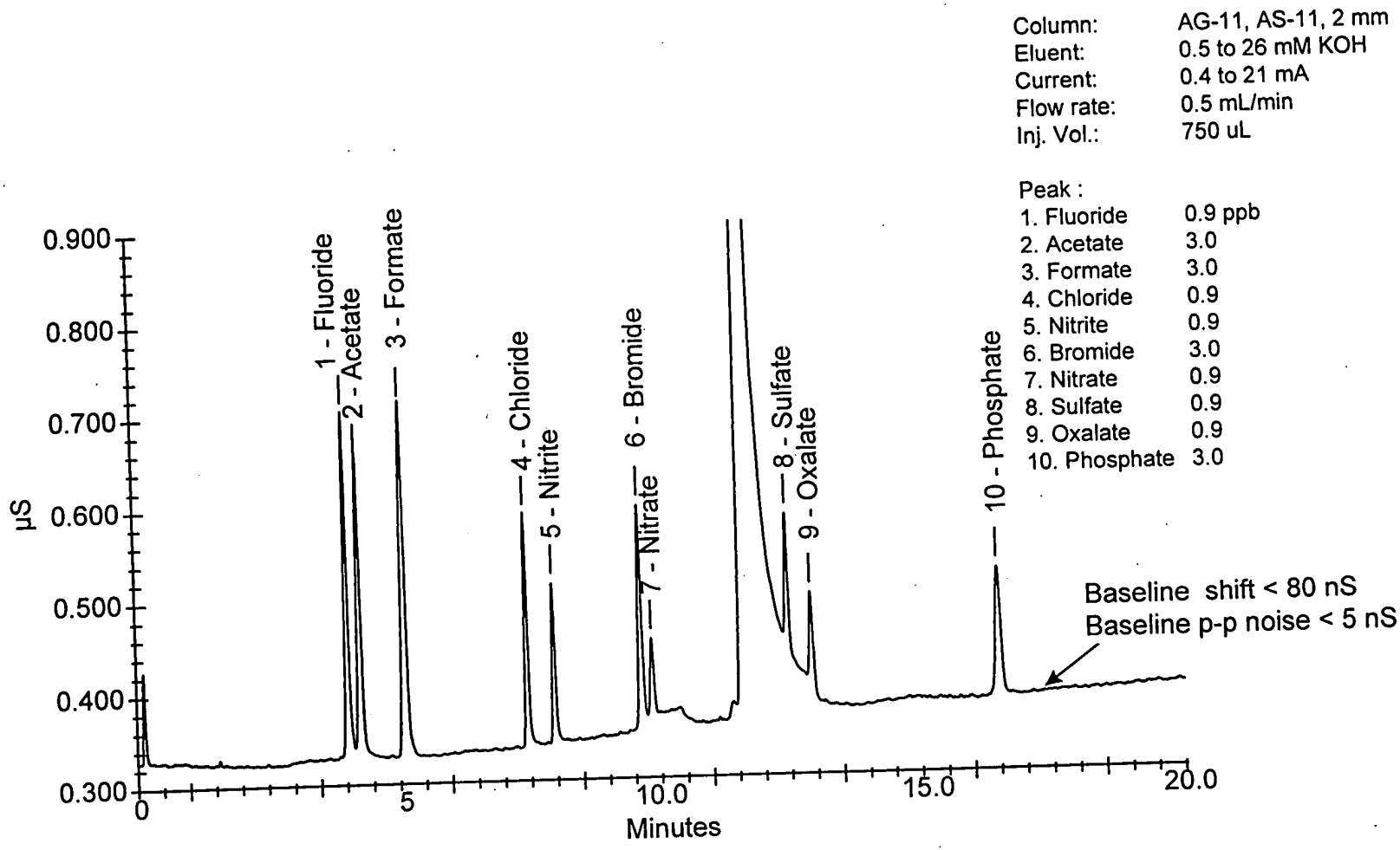

Column: AG-11, AS-11, 2 mm
Eluent: 0.5 to 26 mM KOH
Current: 0.4 to 21 mA
Flow rate: 0.5 mL/min
Inj. Vol.: 750 uL
Peak :
1. Fluoride 0.9 ppb
2. Acetate 3.0
3. Formate 3.0
4. Chloride 0.9
5. Nitrite 0.9
6. Bromide 3.0
7. Nitrate 0.9
8. Sulfate 0.9
9. Oxalate 0.9
10. Phosphate 3.0
1 - Fluoride
2 - Acetate
3 - Formate
4 - Chloride
5 - Nitrite
6 - Bromide
7 - Nitrate
8 - Sulfate
9 - Oxalate
10 - Phosphate
Baseline shift < 80 nS
Baseline p-p noise < 5 nS
µS
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0
5
10.0
15.0
20.0
Minutes

Figure 24.

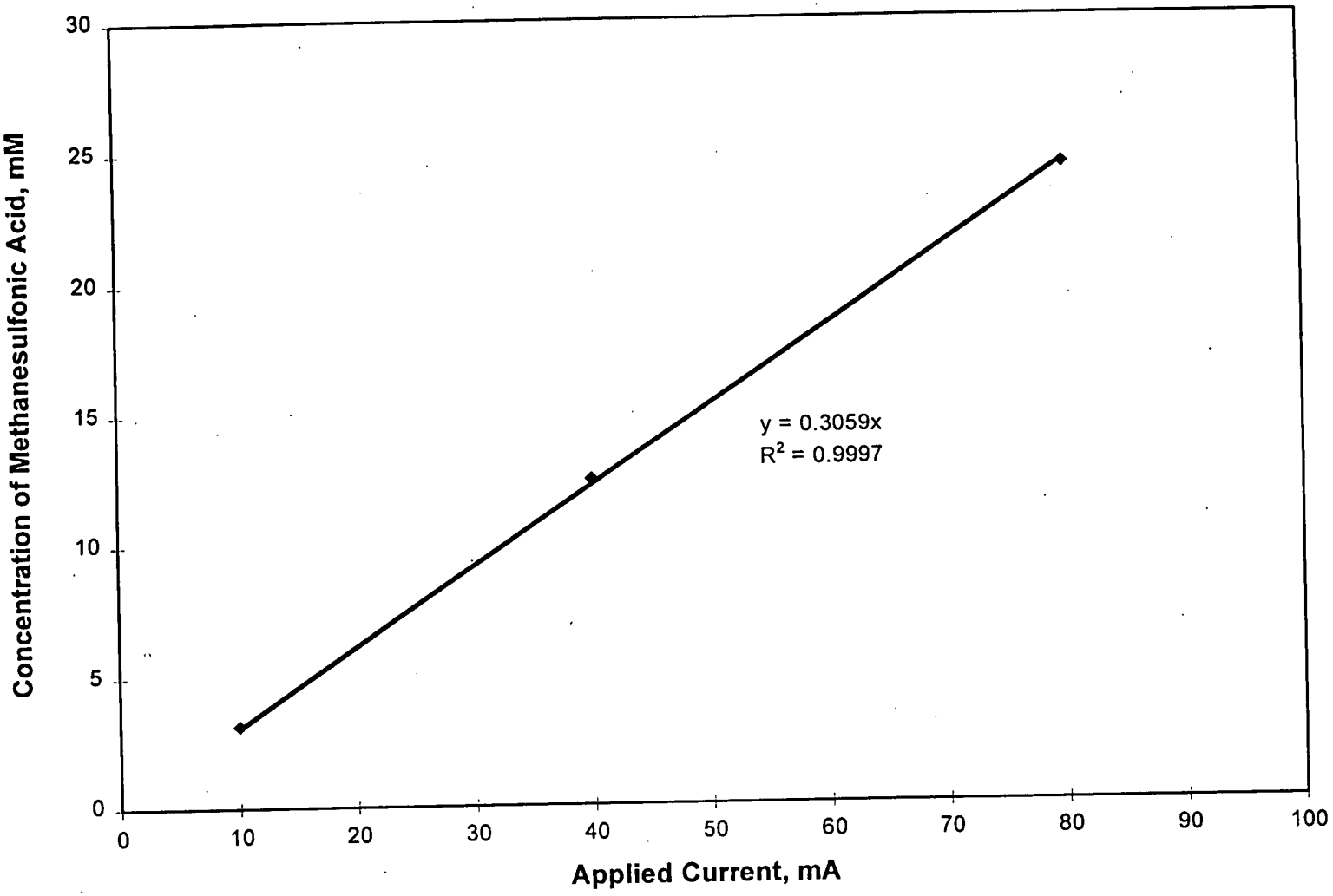

Concentration of Methanesulfonic Acid, mM
Applied Current, mA
y = 0.3059x
R2 = 0.9997
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
80
90
100

Figure 25.

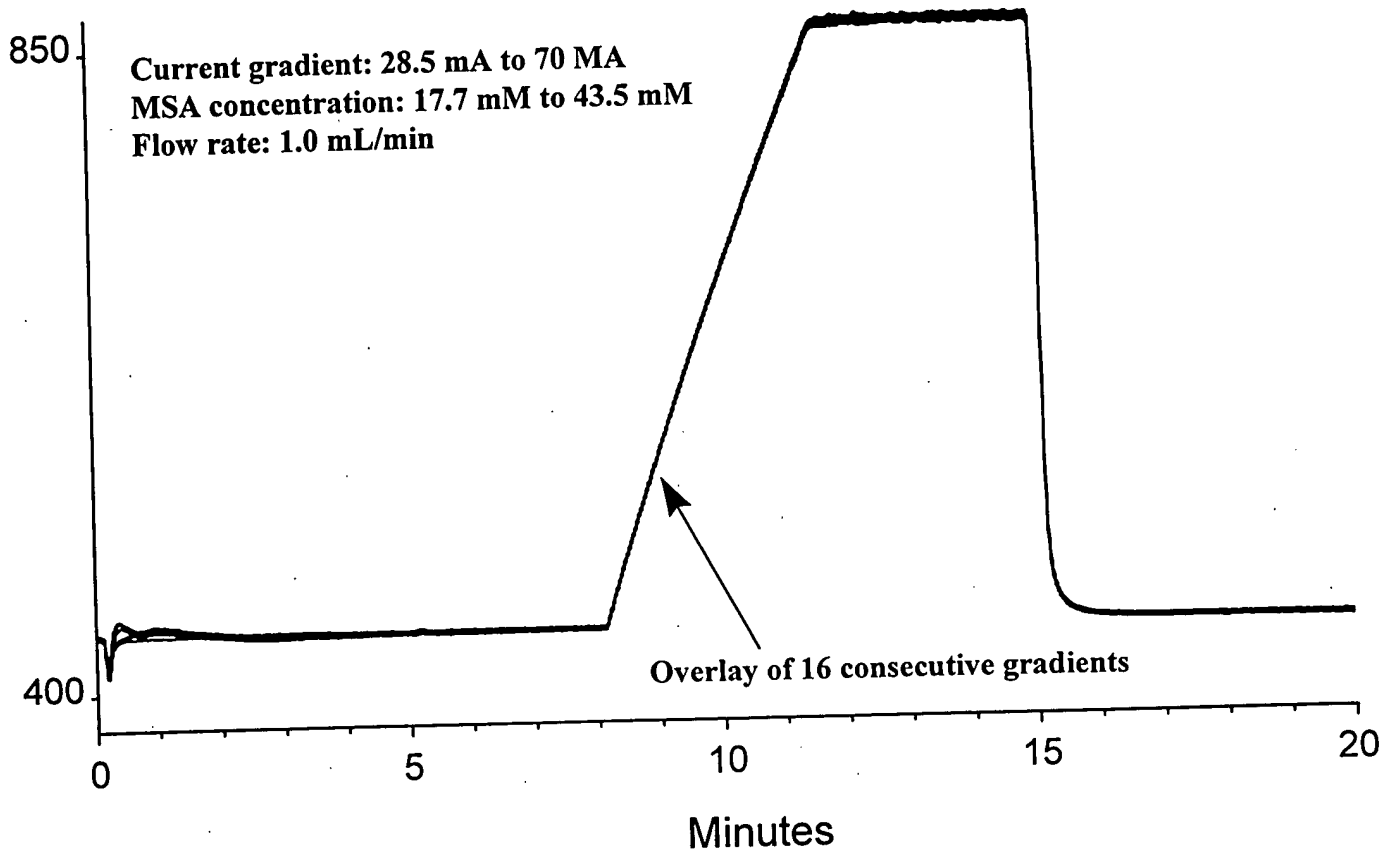

850
400
Current gradient: 28.5 mA to 70 MA
MSA concentration: 17.7 mM to 43.5 mM
Flow rate: 1.0 mL/min
Overlay of 16 consecutive gradients
0
5
10
15
20
Minutes

Figure 26

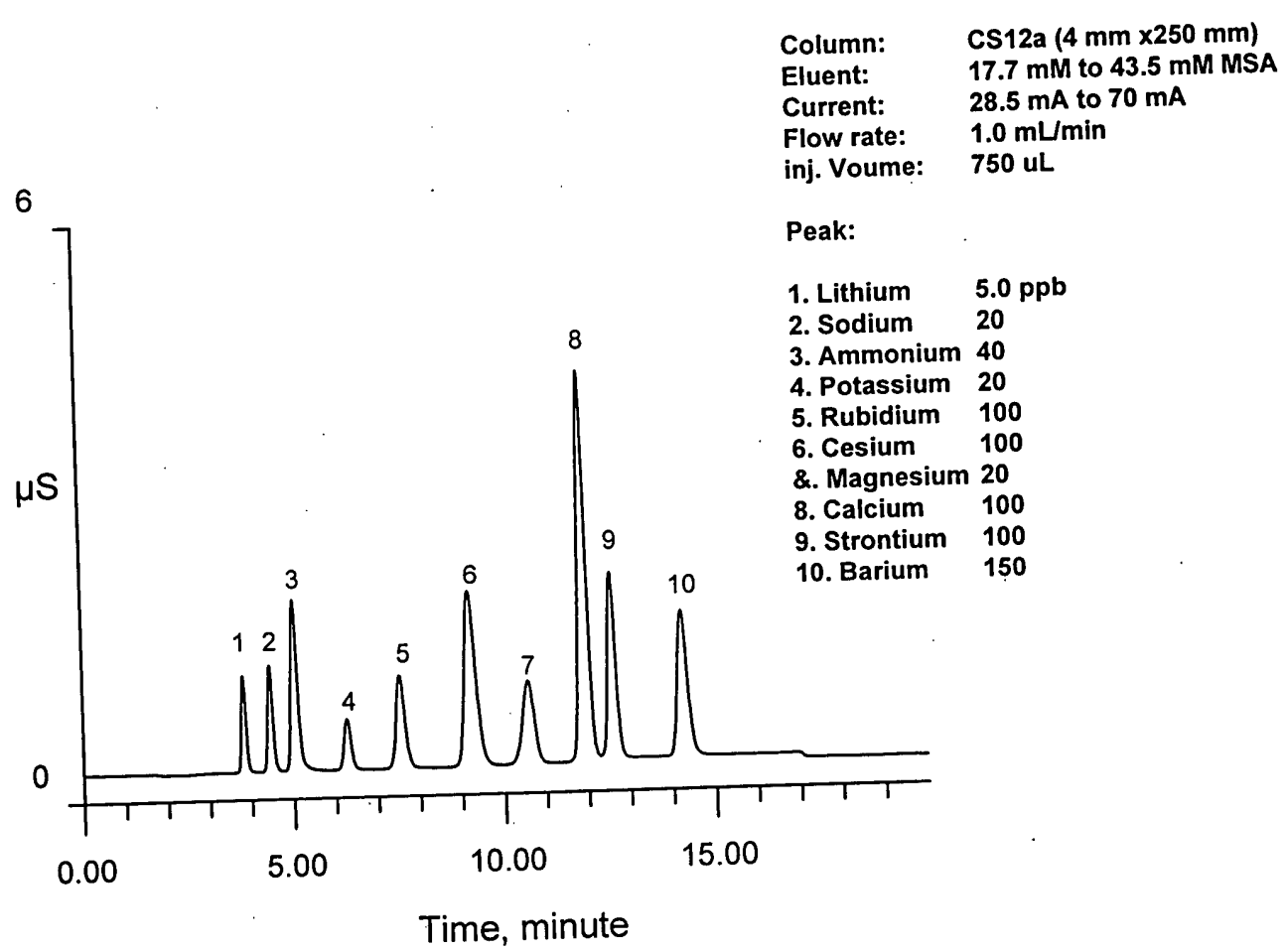

Column: CS12a (4 mm x250 mm)
Eluent: 17.7 mM to 43.5 mM MSA
Current: 28.5 mA to 70 mA
Flow rate: 1.0 mL/min
inj. Voume: 750 uL
Peak:
1. Lithium 5.0 ppb
2. Sodium 20
3. Ammonium 40
4. Potassium 20
5. Rubidium 100
6. Cesium 100
&. Magnesium 20
8. Calcium 100
9. Strontium 100
10. Barium 150
6
µS
0
1 2 3 4 5 6 7 8 9 10
0.00 5.00 10.00 15.00
Time, minute

Figure 27.

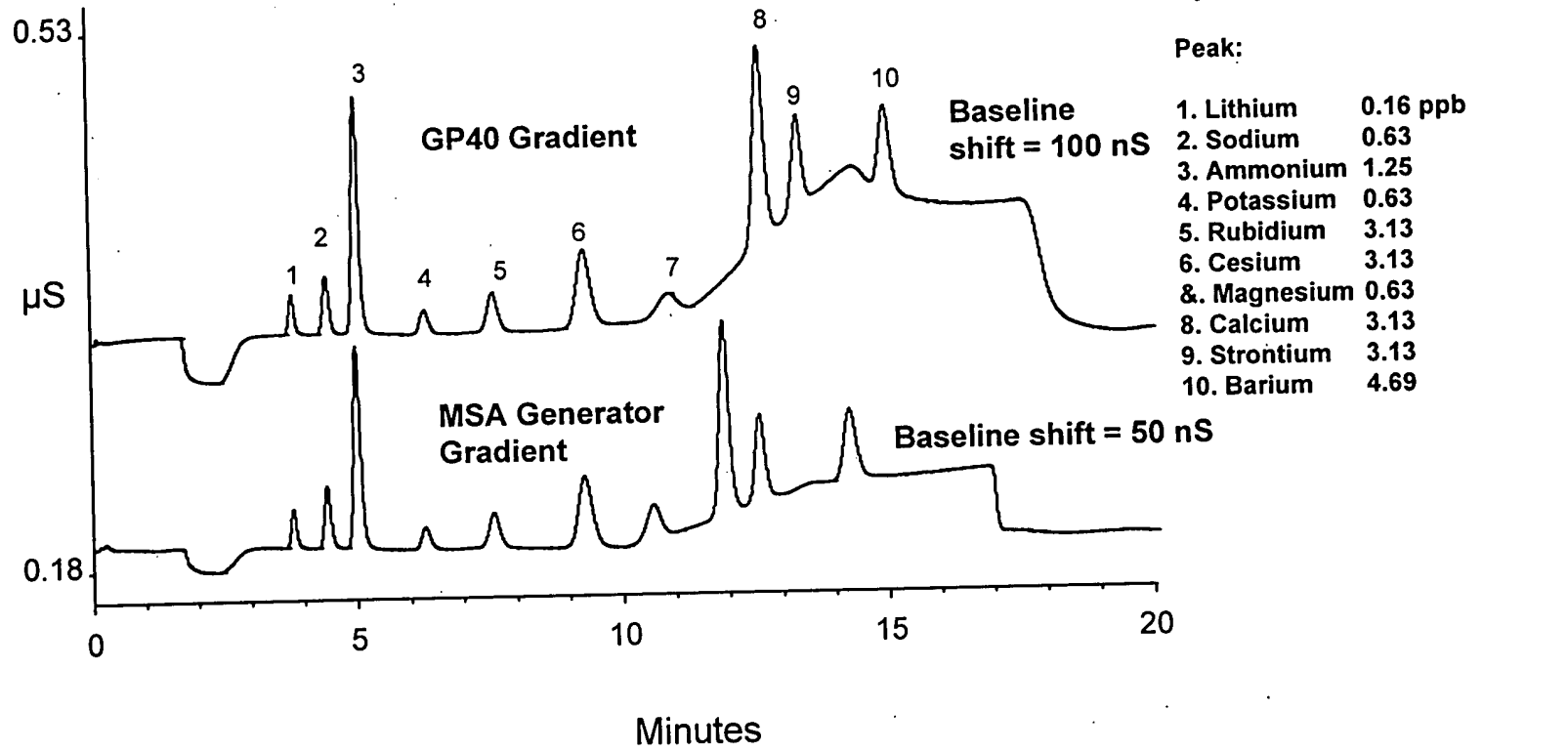

0.53
0.18
µS
GP40 Gradient
MSA Generator Gradient
Baseline shift = 100 nS
Baseline shift = 50 nS
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
Minutes
Column: CS12a (4 mm x250 mm)
Eluent: 17.7 mM to 43.5 mM MSA
Flow rate: 1.0 mL/min
inj. Voume: 750 uL
Peak:
1. Lithium 0.16 ppb
2. Sodium 0.63
3. Ammonium 1.25
4. Potassium 0.63
5. Rubidium 3.13
6. Cesium 3.13
&. Magnesium 0.63
8. Calcium 3.13
9. Strontium 3.13
10. Barium 4.69

Figure 28.

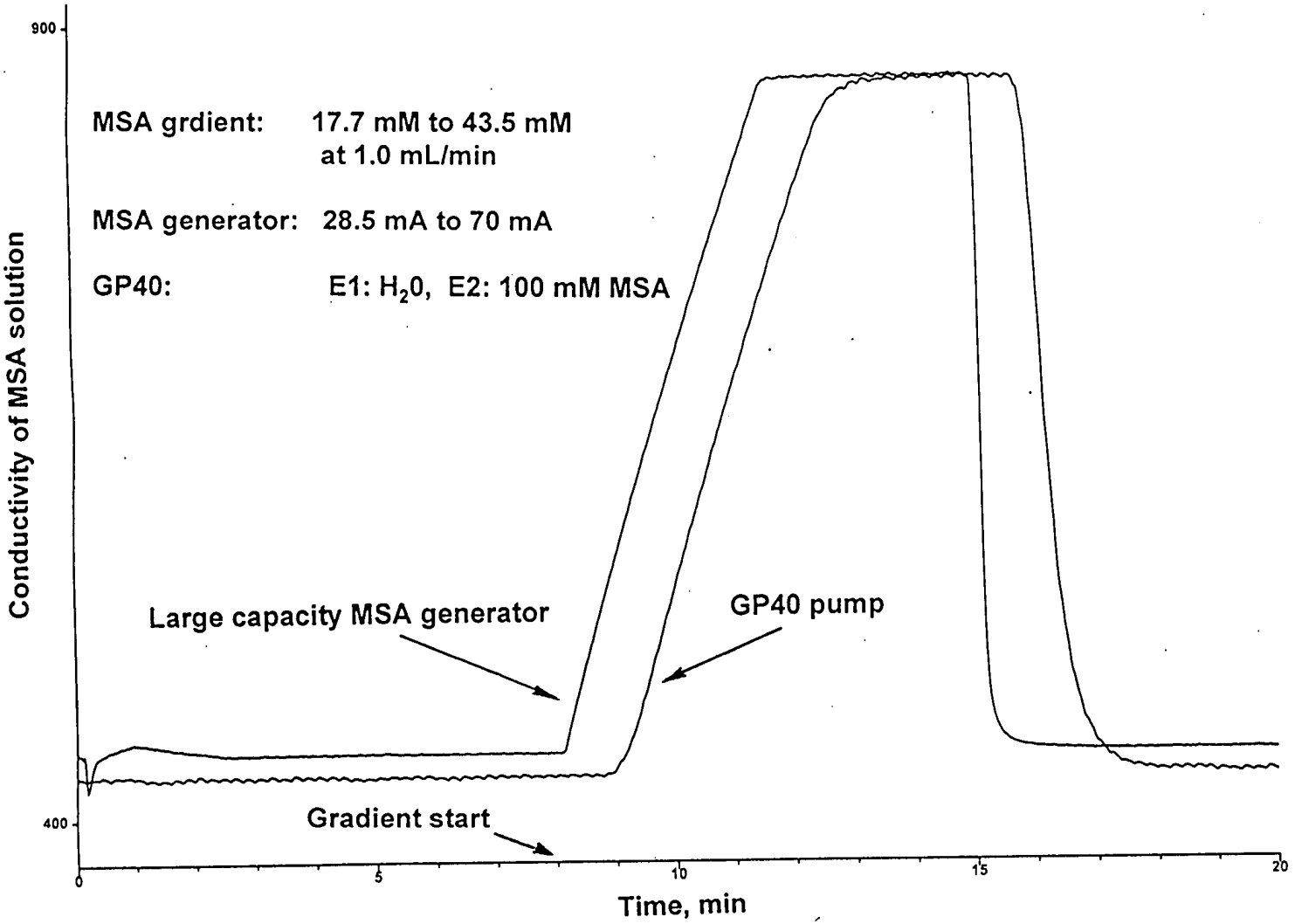

900
400
Conductivity of MSA solution
MSA grdient: 17.7 mM to 43.5 mM
at 1.0 mL/min
MSA generator: 28.5 mA to 70 mA
GP40: E1: H20, E2: 100 mM MSA
Large capacity MSA generator
GP40 pump
Gradient start
0
5
10
15
20
Time, min

Figure 29.